

No. 2016-1996

**United States Court of Appeals
for the Federal Circuit**

HONEYWELL INTERNATIONAL INC.,
Appellant,

v.

MEXICHEM AMANCO HOLDING S.A. DE C.V. and
DAIKIN INDUSTRIES, LTD.,
Appellees.

Appeal from the U.S. Patent and Trademark Office, Patent Trial and
Appeal Board in Reexamination Nos. 95/002,189 and 95/002,204

**APPELLANT'S OPENING BRIEF
(Corrected)**

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U.S. Patent No. 7,534,366, claim 1 (Appx0059):

1. A heat transfer composition for use in an air conditioning system comprising:

(a) at least about 50% by weight of 1,1,1,2-tetrafluoropropene (HFO-1234yf) having no substantial acute toxicity; and

(b) at least one poly alkylene glycol lubricant in the form of a homopolymer or copolymer consisting of 2 or more oxypropylene groups and having a viscosity of from about 10 to about 200 centistokes at about 37°C.

CERTIFICATE OF INTEREST

Counsel for the Appellant Honeywell International Inc. certify the following:

1. The full name of every party or amicus represented by us is Honeywell International Inc.
2. The name of the real party in interest (if the party named in the caption is not the real party in interest) represented by us is: N/A.
3. All parent corporations and any publicly held companies that own 10 percent or more of the stock of the party or amicus curiae represented by us: None.
4. The names of all law firms and the partners or associates that appeared for the party or amicus now represented by us in the trial court or agency or are expected to appear in this court are:

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STATEMENT OF RELATED CASES

Honeywell International Inc. (“Honeywell”) is not aware of any cases pending in this Court or any other court that would directly affect or be directly affected by this Court’s decision in this appeal.

Honeywell International Inc. (“Honeywell”) is cross-appellant in Nos. 2016-1038 and 2016-1041, presently pending before this Court.

ABBREVIATIONS

The following abbreviations are used in this brief:

CFCs	Chlorofluorocarbons
GWP	Global Warming Potential
HCFCs	Hydrochlorofluorocarbons
HFCs	Hydrofluorocarbons
HFOs	Hydrofluoroolefins
ODP	Ozone Depletion Potential
PAG	Polyalkylene Glycol
HFO-1234yf	2,3,3,3-tetrafluoropropene

Note: All quoted emphasis is added unless otherwise indicated.

INTRODUCTION

The Board’s decision must be vacated because it relies on a new ground of rejection without proper notice to Honeywell. Under binding precedent, and statutory and regulatory text, the Board cannot sustain an Examiner’s rejection on “new grounds” without giving the patentee notice and an opportunity to respond. The Board relied on a new prior art reference—“Omure”—to sustain the Examiner’s obviousness rejections. But Omure was not part of the Examiner’s rejection—the Examiner never even mentioned Omure in its 100+ pages of decisions and office actions—and the Board could therefore not rely on it. Thus, here as in numerous other cases where the Board has relied improperly on new grounds of rejection, this Court must vacate and remand.

In addition to that procedural infirmity, the Board’s substantive analysis of obviousness runs afoul of precedent. This Court and the Supreme Court have consistently cautioned against hindsight in an obviousness analysis. It is fundamental that “a patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007). The patent challenger must ex-

plain *why* a person of ordinary skill would have combined the elements in the manner claimed. And the factfinder must always consider objective evidence indicating that a person of ordinary skill would *not* have done so. It is only through hindsight and disregard of that precedent that the Board found Honeywell's '366 patent, entitled to a 2002 priority date, invalid in 2016.

Honeywell's patent describes and claims a major breakthrough in refrigeration technology. In the 1980s and 1990s, governments and industry worldwide searched for new heat transfer compositions that met both preexisting performance criteria and new environmental criteria that were often inversely correlated. Those efforts involved agencies such as NASA and major transnational chemical companies. Honeywell succeeded in 2002 where others failed for decades because Honeywell looked where prior art consistently taught not to look. Well-documented conventional wisdom taught to avoid "*unsaturated*" compounds in heat transfer compositions. That class of compounds was understood to be too reactive, toxic, and flammable to be safe or useful, and *none* were previously used as commercial refrigerants. Honeywell discovered, however, that a composition of a particular unsaturated compound (HFO-

1234yf) and a particular type of lubricant (polyalkylene glycol or “PAG”), met performance criteria and environmental criteria that prior compositions did not. Honeywell’s invention was and continues to be an immediate success.

Nonetheless, Honeywell’s competitors argued in 2012 that Honeywell’s invention must have been obvious all along, largely because the two components (HFO-1234yf and PAG lubricant) existed separately in the prior art. An abandoned 1992 Daikin patent application (“Inagaki”), provided a largely undifferentiated description of 30 compounds including the HFO-1234yf refrigerant. Not even Daikin thought HFO-1234yf had any promise until Honeywell discovered and invested considerably to develop its patented composition ten years later. Other references generally disclosed PAG lubricants. Mexichem and Daikin thus argued, in hindsight, Honeywell’s invention was merely the routine testing of one of the 30 compounds in Daikin’s abandoned patent application with various lubricants mentioned in other references. Mexichem and Daikin glossed over the undisputed unpredictability of lubricant-refrigerant combinations, undisputed teachings to *avoid* unsaturated compounds, and Honeywell’s success in 2002 after undisputed decades of failures.

Under a proper analysis, those considerations should have alerted the Board to the hindsight inherent in Mexichem and Daikin's arguments.

The Board ran afoul of precedent primarily in two ways. First, it held the unpredictability of this field against Honeywell—essentially reasoning that because *no* result could be predicted in advance, *every* combination must necessarily be equally obvious. Second, the Board discounted Honeywell's evidence of unexpected results and other objective evidence of nonobviousness. Although such evidence is relatively rare at the Patent Office, it is an important safeguard against hindsight, must be considered when present, and was not considered appropriately here. Whether for procedural reasons, substantive, or both, the Board's decision cannot stand.

JURISDICTIONAL STATEMENT

The Board had jurisdiction under 35 U.S.C. § 134; its Decision on Appeal issued on March 30, 2016. Appx0001. Honeywell timely appealed on May 3, 2016. Appx5835-5836; 35 U.S.C. §§ 141-142; 37 C.F.R. § 1.983. This Court has jurisdiction under 35 U.S.C. § 141 and 28 U.S.C. § 1295(a)(4)(A).

STATEMENT OF THE ISSUES

1. Whether the Board's decision must be vacated because the Board relied improperly on a new ground of rejection (obvious combination of references including Omure) without proper notice to Honeywell.

2. Whether the Board's decision must be reversed because the Board: (a) relied on hindsight to find that a person of ordinary skill in the art would have combined disparate disclosures in Inagaki and other references to arrive at the claimed invention, and (b) failed to give due weight to Honeywell's objective evidence supporting nonobviousness.

3. Whether the Board's decision must be reversed, at a minimum as to as to claims 36, 37, 46-49, 70, and 75, because the Board held that those claims "optimized" certain properties, without any predicate finding—or any basis for one—that one of ordinary skill would have recognized those properties as result-effective variables in the first place.

STATEMENT OF THE CASE

This appeal arises out of two merged *inter partes* reexaminations concerning the '366 patent. The Examiner found all challenged claims

obvious. Honeywell appealed. Appx2606-2607. The Board affirmed. Appx0049-0050. Honeywell now appeals to this Court.

I. Background

A heat transfer composition is a refrigerant mixed with a lubricant. Honeywell's '366 patent describes and claims novel heat transfer compositions comprising specific amounts of 2,3,3,3-tetrafluoropropene ("HFO-1234yf") refrigerant and PAG lubricant meeting specific characteristics. Appx0059.

A. Refrigerant Technology

A heat transfer system—*e.g.*, an air conditioner or refrigerator—cools a space by drawing heat from the space and transferring the heat out. Heat is drawn into the refrigerant, the heated refrigerant is moved outside the space, the heat is released from the refrigerant, and then the refrigerant is returned to the space to restart the cycle. Appx0053(1:35-46). A compressor circulates the refrigerant through the system. *Id.* To keep the system running, lubricants are often mixed with the refrigerant. Appx0566(¶14).

Very few chemicals can function as commercial refrigerants. The refrigerant must perform properly not merely in isolation, but in combi-

nation with the lubricant. An acceptable refrigerant must have at least the following four properties. And an acceptable refrigerant-lubricant composition must maintain those properties across the range of temperatures, pressures, and phase changes inherent in a heat transfer system:

Heat transfer characteristics. Refrigerants must draw high amounts of heat from the area to be cooled when they evaporate, and transfer high amounts of heat when they condense. Appx0364(¶8); Appx0053(2:13-14). The relevant metrics are capacity and coefficient of performance (“COP”). Appx0058(11:38-51). When replacing a preexisting refrigerant composition with a new one, the new refrigerant should be effective without requiring major engineering changes to preexisting technology used with the old refrigerant. Appx0053(2:41-45).

Low or no toxicity or flammability. Refrigerants are used in applications including appliances, buildings, cars, boats, and planes. Depending on the application, consequences of a leak could range from problematic to deadly if the refrigerant is toxic or flammable. Appx0364(¶8); Appx0613-0614(¶¶4-5); Appx0616(¶14); Appx0618(¶26); Appx0053(2:46-61).

Refrigerant/lubricant miscibility. “Miscibility” is the property of two substances to mix evenly together. Miscibility is a function of temperature at a given concentration. Appx0567(¶16); Appx0465-0466(¶10). If the refrigerant and lubricant are insufficiently miscible, “lubricants tend to become lodged in the coils of the evaporator ... as well as other parts of the system, and thus reduce system efficiency.” Appx0053(2:32-35); Appx0566(¶14); Appx0567(¶17).

Thermal and chemical stability between the refrigerant, lubricant, and system machinery. The refrigerant must remain stable across a wide range of temperatures and pressures that includes a phase change between gas and liquid. Across that same range of temperatures and pressures, the lubricant must also remain stable, and the refrigerant and lubricant must not react chemically with each other or with the heat transfer system machinery. Appx0053(2:12-14); Appx0364(¶8).

B. Environmental Concerns

Before Honeywell’s invention in 2002, all commercial fluorocarbon heat transfer systems used *saturated* compounds as refrigerants. Appx0364(¶7). In saturated compounds, every carbon atom is attached

to other atoms by a *single* bond. *Id.* Unsaturated compounds contain one or more *double* bonds between carbon atoms. *Id.*

Until the 1970s, chlorofluorocarbon (“CFC”) refrigerants such as Freon predominated. Appx0615-0616(¶13).

In the ensuing decades, chlorofluorocarbons were linked to ozone depletion and climate change. Appx0615-0616(¶13); Appx1783-1787(¶¶2-6). As most industrialized countries signed treaties agreeing to phase out CFCs, industry faced the challenge of finding new refrigerants that met performance and safety criteria and new environmental criteria.

By 2002, two metrics measured relevant environmental criteria: “Ozone Depletion Potential” (ODP) and “Global Warming Potential” (GWP). Appx0053(1:60-2:9); Appx0364(¶8); Appx1786-1787(¶6); Appx0615-0616(¶¶12-13). ODP measures degradation to the ozone layer; GWP measures a chemical’s ability to trap heat in the atmosphere. Appx0055(5:30-46).

C. Industry Search for New Refrigerants

In response to environmental concerns, industry first switched from CFCs to HCFCs, which had lower ODP, but high GWP.

Appx0616(¶¶14-15). Industry later moved toward saturated HFCs, which had zero ODP, but high GWP. *Id.*; Appx1786-1787(¶6). Over time, governments and scientists increasingly prioritized environmental criteria and enacted stringent regulations. Appx1785-1786(¶5); Appx0615-0616(¶¶12-14).

The introduction of ODP- and GWP-related regulations complicated the search, because in many chemicals those criteria correlate inversely with each other and with performance criteria. A refrigerant that reacts with ozone (high ODP) may break down more readily in the atmosphere (low GWP), and may thus also break down readily in the heat transfer system, Appx4148-4149, or be flammable. Appx0618(¶¶26-27); Appx0930(fig. 8). By 2002, industry had identified some HCFCs and HFCs as having low or zero *ODP*, but was no closer to finding acceptable compounds that also had low *GWP*. Appx0615-0616(¶¶12-14).

During their decades-long search for suitable refrigerants, investigators examined a broad range of chemicals, including fluorinated ketones, alcohols, amines, silicon and sulfur-containing compounds, and gases such as CO₂ and NH₃. Appx0365(¶9); Appx1786-1787(¶6). Thou-

sands of compounds and possible combinations existed, many of which had to be tested—alone, and in combination with lubricants and other materials—before their suitability could be known. Appx0365(¶9).

Few guideposts existed for narrowing the thousands of alternatives. Appx0365(¶9). One clear guidepost by 2002, however, was the consistent teaching to avoid unsaturated compounds. Appx0364(¶7); Appx0365-0366(¶¶9-10); Appx0366-0367(¶13); Appx0613-0614(¶¶4-5). Unsaturated fluorocarbons had never been used as commercial refrigerants, and were regarded as a class to be reactive, unstable, toxic, and flammable—in other words, everything a refrigerant should not be. Appx0364(¶7); Appx0365-0366(¶¶9-10); Appx0366-0367(¶13); Appx0613-0614(¶¶4-5); Appx0618(¶24). The following examples illustrate that understanding:

1. A 1987 publication seeking replacements for CFCs stated that “compounds containing a carbon-carbon double bond [were] not considered because of their lower stability.” Appx0928(n.4).

2. A 1989 publication, “Beyond CFCs: Extending the Search for New Refrigerants,” described unsaturated compounds as “of questionable value as refrigerants” due to stability and toxicity concerns,

Appx0459, and concluded: “It is likely that *none of the compounds* based on ethylene, propylene, or acetone are both nonflammable and low in toxicity.” *Id.* Propylene (another word for propene) and ethylene are unsaturated compounds.

3. A U.S. patent with a 1989 priority date referred to unsaturated compounds as “impurities” and “particularly undesirable ... contaminants [that] may be toxic” and thus “must be lowered to as low a level as is practically possible.” Appx10738(2:28-33); *see also* Appx4303:3-17 (Mexichem’s expert acknowledging that this would “suggest against toxic olefins as refrigerants.”).

4. A 1992 NASA publication considered numerous compounds as potential refrigerants, and dismissed the thirteen unsaturated compounds as “reactive.”

Refrig	Chem Formula	Name	(°C) MBP	Accept/ Reject	Comments
40	CH ₃ Cl	Methyl Chloride	-24.22	R	Toxic
1131a	CClF=CH ₂	1-Chloro-1-fluoroethane	-24.00	R	Reactive
1261ya	CH ₃ CF=CH ₂	2-Fluoropropene	-24.00	R	Reactive
11581	CBrF ₂ CF ₃	Bromopentafluoroethane	-22.00	R	Toxic
1225zc	CF ₃ CH=CF ₂	1,1,1,3,3-Pentafluoropropene	-21.00	R	Reactive
134	CHF ₂ CHF ₂	1,1,2,2-Tetrafluoroethane	-19.72	A	Toxicity unknown (sim to R134a?)
1122	CHCl=CF ₂	1-Chloro-2,2-Difluoroethane	-18.48	R	Reactive
227ea	CF ₃ CHFCF ₃	1,1,1,2,3,3,3-Heptafluoropropane	-18.00	R	Toxicity unknown
1243zf	CF ₃ CH=CH ₂	1,1,1-Trifluoropropene	-18.00	R	Reactive

Appx0407-0449 (highlighting added).

5. A Mexichem white paper, discussing a 1997 screening for CFC replacements, stated that “the initial screening... ruled out any compounds identified as unacceptably ‘reactive’ including those containing functional groups *such as double bonds*.” Appx4149.

6. A U.S. patent with a 2000 priority date—on which Mexichem’s expert Dr. Corr is an inventor—describes hydrohalopropenes (which include HFOs) as “impurities” to be removed. Appx4086(3:13-43); Appx4466:17-4467:21.

By 2002, *every* commercial refrigerant—including HCFCs and HFCs—was a saturated compound. Appx0364(¶7). Even in 2006, industry standards limited the presence of classes of unsaturated compounds labeled as “volatile impurities.” Appx2630 (citing ARI 2006 Standard 700 at 4, ¶5.11.2.1). And as recently as 2010, Mexichem has acknowledged that HFOs are “two orders of magnitude” more reactive than HFC-134a (the most popular commercial refrigerant before Honeywell’s invention). Appx4148.

D. Honeywell’s Discovery of a Novel Refrigerant-Lubricant Combination and ’366 Patent

By 2002, numerous multinational chemical companies, trade organizations, U.S. government agencies, foreign governments, and others,

had committed resources to finding new refrigerants with sufficiently low ODP and GWP. Appx0365(¶9). Honeywell succeeded in 2002, by discovering an unexpected combination of refrigerant and lubricant: HFO-1234yf refrigerant with PAG lubricant. Appx0366-0367(¶¶11-13); Appx0616-0617(¶¶17-22).

1. Honeywell's '366 Patent

Honeywell's '366 patent is titled *Compositions Containing Fluorine Substituted Olefins* and has an October 25, 2002 priority date. Appx0052. All claims depend from claim 1, which is reproduced on this brief's inside-front cover and below:

1. A heat transfer composition for use in an air conditioning system comprising:

(a) at least about 50% by weight of 1,1,1,2-tetrafluoropropene (HFO-1234yf) having no substantial acute toxicity; and

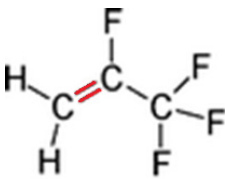
(b) at least one poly alkylene glycol lubricant in the form of a homopolymer or copolymer consisting of 2 or more oxypropylene groups and having a viscosity of from about 10 to about 200 centistokes at about 37°C.

Appx2646. The patent originally issued with twenty-five claims. Honeywell proposed amendments during reexamination that left the original claims unchanged and added claims. Appx1322-1330; Appx2125-2132. Those claims are at Appx2646-2652.

2. HFO-1234yf

HFO-1234yf—the refrigerant in all claims—is an unsaturated hydrofluorocarbon. The “O” denotes that it is an “olefin.” An olefin has at least one carbon-carbon double bond. Olefins may also be called alkenes, alkylenes, or *unsaturated* hydrocarbons. The double bond makes these compounds “unsaturated,” as explained above. *Statement of the Case* §§ I.A, I.C, *supra*.

As shown below, HFO-1234yf is also referred to in the record as “2,3,3,3-tetrafluoropropene,” “1,1,1,2-tetrafluoropropene,” “R-1234yf,” or by the formulas shown below, which all convey that the compound is unsaturated.

Name	2,3,3,3-tetrafluoropropene or 1,1,1,2-tetrafluoropropene	“e” indicates that the compound is an alkene, and is unsaturated. (“Propane,” for example, is an alkane, a saturated compound).
Formula	$\text{F}_3\text{C}-\text{CF}=\text{CH}_2$ 	“=” indicates that two atoms are joined by a double bond.
Type	HFO -1234yf	HFO prefix indicates that the compound is a hydrofluoroolefin
Number	R- 1234 yf	The four -digit number indicates that the compound is unsaturated.

Honeywell's use of the unsaturated compound HFO-1234yf in a heat transfer composition was novel in several respects.

Every preexisting commercial heat transfer composition had used a saturated refrigerant—consistent with the prior art teaching to avoid unsaturated compounds for performance and safety reasons. Appx0364(¶7); Appx0365-0366(¶¶9-10); Appx0366-0367(¶13); Appx0613-0614(¶¶4-5); Appx0618(¶24). Honeywell's scientists discovered that HFO-1234yf did not pose similar problems. Appx0366(¶12); Appx0613-0614(¶¶5-9); Appx0617(¶19); Appx0568-0569(¶¶23-26).

Honeywell also discovered that HFO-1234yf had unexpectedly low GWP. The most popular preexisting commercial refrigerant, HFC-134a, had a GWP of 1300 (traps 1300 times more heat in the atmosphere than carbon dioxide), *see* Appx1006, Appx0975, while the GWP of HFO-1234yf was just *four*. Appx0617(¶19).

3. Polyalkylene Glycol (PAG) Lubricant

Honeywell's successful use of PAG lubricant in combination with an unsaturated refrigerant was also novel.

The refrigerant and lubricant in a heat transfer composition should be miscible together and must be stable in combination. *See*

Statement of the Case § I.A, supra; Appx0566-0567(¶¶13-17); Appx1814-1815(¶¶3-5); Appx0364(¶8). PAG lubricants are synthetic. PAG lubricants were known in the art, but known to have drawbacks such as hygroscopicity (capacity to absorb moisture) and reactivity, and were known to be immiscible with numerous refrigerants. Appx0370(¶21); Appx0467-0468(¶¶12-14); Appx1814-1815(¶¶4-5); Appx6017(1:44-51); Appx1860-1861; Appx1867-1868; Appx1880; Appx1891; Appx1897; Appx1911-1913; Appx1919-1920; Appx5997(2:35-40); Appx10718(1:46-54); Appx10725-10732 (Acura). The miscibility of a PAG lubricant with a refrigerant was not predictable in advance and required testing. Appx0370(¶21); Appx0465-0469(¶¶10-17); Appx0617-0618(¶23). Among Honeywell's unexpected discoveries was that HFO-1234yf and PAG lubricants were stable in combination and miscible over a broad range of concentrations and temperatures, which meant that the combination could be used in a wide variety of applications, such as air conditioning. Appx0567-0569(¶¶17-26); Appx0577-0578; Appx0579-0583; Appx0607-0608.

4. Commercialization

After its discovery, Honeywell moved to commercialize its invention. Honeywell's efforts met with immediate success. Hydrofluoroolefins such as HFO-1234yf are now regarded as a "fourth generation of refrigerants" and a "step-change improvement on the previous generation." Appx4512. Honeywell expects that between 2012 and 2017, it will have delivered over 20 *million* pounds of HFO-1234yf to its customers. Appx6578(¶6).

Donald Bivens—the inventor of a prior art patent cited in this case, a Ph.D. chemical engineer by training, and a 30-year employee of DuPont in charge of DuPont's participation in the worldwide search for new refrigerants—hailed Honeywell's invention as an industry-wide "surprise" and "without reservation ... the most significant discovery that occurred during my 30 year career in the entire field of refrigerant applications." Appx0366(¶11).

II. Proceedings Below

A. Mexichem and Daikin's Petitions

On the same day in 2012, Honeywell's competitors Mexichem and Daikin each filed petitions for *inter partes* reexamination of Honeywell's '366 patent. Appx0136-0189; Appx5888-5968. Both alleged that

the claims were obvious in light of Inagaki in view of additional references: Magid, an Acura Service Bulletin, Bivens, or alleged “admissions” in prosecution. Appx0138-0139 (Mexichem’s petition); Appx5892-5893 (Daikin’s petition). Both argued that Inagaki taught the HFO-1234yf compound, that Bivens, Magid, the Acura Service Bulletin, and “Patentee’s Admissions” taught the use of PAG lubricants, and that the claimed combinations were obvious. Appx0136-0189; Appx5888-5968.

1. Inagaki

Inagaki is an abandoned Japanese patent application, owned by Daikin. Inagaki was filed in 1990 and published in 1992—ten years before Honeywell’s invention. Appx5987-5994. Inagaki is titled *Fluid for Heat Transfer*, and discusses a group of thirty unsaturated compounds. *Id.*

Inagaki’s authors sought cooling media with “fewer destructive capabilities against the ozone layer”—*i.e.*, ODP. Appx5987-5994. Inagaki identifies five compounds as “examples” or “embodiments” without expressing a preference for any of them. *Id.*; Appx0367(¶14).

Inagaki’s “Embodiment 5” is “F₃C-CF=CH₂,” or HFO-1234yf. Although Inagaki reports performance values of the other four “embodi-

ments,” for HFO-1234yf Inagaki states only that Embodiment 5 was tested “in a similar manner” to Embodiment 1 and produced “almost similar results”:

The operation of the heat pump of the present embodiment was performed in a similar manner as Embodiment 1 except for $\text{F}_3\text{C-CF=CH}_2$ was used as the heat medium and the almost similar results as those of Embodiment 1 were obtained.

Appx5990. “Embodiment 1” is HFO-1243zf, which undisputedly has *un*-acceptable toxicity and flammability for air conditioning applications. Appx0367-0368(¶¶14-15); Appx0613-0614(¶5).

Inagaki also refers to the use of “machine oil,” Appx5988, but does not mention the use of any particular lubricant. Appx5987-5994. Rather, Inagaki “confirmed that the mixtures of $\text{C}_3\text{H}_m\text{F}_n$ and at least one compound selected from a group consisting of R-22, R-32, R-124, R-125, R-134a, R-142b, R-143a and R-152a do not have any problem with respect to their general characteristics (e.g., compatibility with lubricants, non-erodibility against materials etc.).” Appx5989. As noted above, after Inagaki was published, NASA testing rejected thirteen unsaturated compounds as “reactive”—including three of the compounds referred to in Inagaki. Appx0418-0419.

2. Secondary References

Bivens. U.S. Patent No. 6,783,691 (“Bivens”) was filed in 2000, and is directed to refrigerant compositions using three specific saturated hydrofluorocarbons and one saturated hydrocarbon. Appx10717(abs.). Compared to Honeywell’s ’366 patent, Bivens focuses on making different lubricants (not PAGs) work with different refrigerants (not unsaturated compounds). Bivens notes that polyol esters and PAGs are expensive and have numerous drawbacks. Appx10718(1:47-59). Bivens notes that while mineral oil and alkylbenzene lubricants are superior in several ways to polyol esters and PAGs, they are thought to be relatively insoluble in commercial, saturated HFC-based heat transfer systems. Appx10718(1:59-62). Bivens thus focuses on improving the utility of mineral oil and alkylbenzene lubricants by resolving their associated solubility problems. *Id.*

The Examiner, Mexichem, and Daikin relied on Bivens for two sound bites. In the background of the invention, Bivens explains why the inventor focused on improving mineral oil and alkylbenzene lubricants:

Mineral oils and alkylbenzenes have been conventionally used as lubricants in CFC-based refrigeration

systems. However, the lack of solubility of these lubricants in HFC-based refrigerants has precluded their use and necessitated development and use of alternative lubricants for *HFC-based refrigeration systems, which utilize polyalkylene glycols (PAGs) and polyol esters (POEs)*. A lubricant change from mineral oil or alkyl benzene to POE or PAG lubricants (which increases expenses in the refrigeration industry) is required when the HFC mixtures are used to replace CFC-based refrigerants.

While the PAGs and POEs are suitable lubricants for HFC-based systems, they are extremely hygroscopic and can absorb several thousand ppm (parts per million) of water upon exposure to moist air. This absorbed moisture leads to problems in the refrigeration system, such as formation of acids which causes corrosion of the refrigeration system, and the formation of intractable sludges.

Appx10718(1:37-54) (emphases and paragraph break added). The Examiner relied on the italicized clauses above in the obviousness analysis. Appx2565-2566; Appx2583; Appx2587; Appx2600-2601. In the Examiner's view, those sentence fragments constituted a broad teaching that "PAGs can be used as alternative lubricants for HFC-based refrigeration systems because of lack of solubility of mineral oils and alkylbenzenes in the HFC-based refrigeration." Appx2583.

As Dr. Bivens later explained, the reference to "HFC-based refrigerants" referred to the "*saturated* HFC refrigerants in use at that time in refrigerant applications"—the only type of HFC refrigerant available.

Appx0371(¶26). Again, by 2002, *every* commercial refrigerant—including HCFCs and HFCs—was saturated. Appx0364(¶7).

Magid. U.S. Patent No. 4,755,316 (“Magid”), was filed in 1987, and describes miscible mixtures of tetrafluoroethane (a saturated HFC) and polyoxyalkylene glycols. Appx5996(abs.). Magid is directed to finding a miscible lubricant for R134a when replacing a prior generation refrigerant. Appx5998(3:60-62, 4:20-33).

The Examiner, Mexichem, and Daikin, relied on Magid for the general structure of a PAG. Appx2553. The Examiner concluded that because Magid taught PAGs used with saturated refrigerants, it would have been obvious to use PAGs with the unsaturated refrigerants of Inagaki. *Id.* Dr. Thomas, a named inventor on the Magid patent, disagreed, stating that he and his co-inventors “did not have haloolefins in mind or any unsaturated compounds.” Appx0569(¶27). The Examiner apparently assumed, however, that the teachings of Magid would apply equally to saturated and unsaturated compounds.

Acura. A 1992 bulletin describes differences in the air conditioning systems in the 1993 models of two Acura cars. The bulletin compares two saturated refrigerants—R-12 and R-134a—and notes the dif-

ferent lubricants necessary for proper operation (mineral oil v. PAG). Appx10725-10732. The bulletin also explains that PAGs are hygroscopic and will “absorb moisture rapidly.” Appx10725. The Examiner relied on Acura, which identified the particular PAG as ND-8, Appx10728, along with a previous Honeywell statement that ND-8 is a PAG lubricant which meets the structural requirements of the claims, to find that it would have been obvious to use ND-8 with HFO-1234yf. Appx2559.

“Patentee’s Admissions” Mexichem and Daikin pointed to statements in the ’366 patent and prosecution, as “admissions.” These include the statement discussed above that a lubricant called ND-8 meets the structural requirements of the claimed lubricant, and a statement in the “Detailed Description of Preferred Embodiments” section of the ’366 patent that “[c]ommonly used refrigerant lubricants such as Polyol Esters (POEs) and Poly Alkylene Glycol (PAGs) that are used in refrigeration machinery with hydrofluorocarbon (HFC) refrigerants may be used with the refrigerant compositions of the present invention.” Appx0055(6:5-9). The Examiner noted these statements in his analysis. Appx2559-2560.

B. Reexamination Before the Examiner

1. Institution, Initial Rejection, and Action Closing Prosecution

The Patent Office instituted reexamination on Daikin's and Mexichem's petitions, and merged the proceedings. Appx0242-0252; Appx6204-6216; Appx0256-0264. The Examiner then issued a non-final rejection that adopted all proposed bases of rejection. Appx0265-0296.

Honeywell responded with arguments and evidence, including declarations from experts, inventors, a Honeywell employee, and prosecution counsel. Appx0297-1333. Honeywell's response also amended the '366 patent by adding new claims 26-81, amending claim 1, and leaving original claims 2-25 in place. Appx1321-1333.

In response to Honeywell, Mexichem submitted a declaration from its employee Dr. Stuart Corr. Appx8091-8144. Mexichem and Daikin also both submitted a new prior art reference, Japanese Patent JP H5-85970 ("Omure"). Appx1357; Appx1565. Daikin mentioned Omure in passing to argue that "it was [] known at the time to use PAG lubricants with unsaturated compounds." Appx1365. Mexichem likewise argued in one sentence that "it was known prior to the present invention... to use PAG lubricants with HFOs in refrigeration systems, as evidenced by

Omure....” Appx1567. The Examiner’s 68-page Action Closing Prosecution maintained the initial rejections, without mentioning Omure. Appx1710-1782.

2. Right of Appeal Notice

Following the Examiner’s Action Closing Prosecution, Honeywell submitted additional comments and evidence. Appx1783-2076; Appx2082-2135; Appx2141-2194. Honeywell also further amended the ’366 claims by withdrawing the previous amendment to claim 1, canceling claims 27-30, 38-45, 50-57, 60, 69, 76-79, and adding new claims 31, 46, 58, 61, 65, 67, 68, 70, 71, 73, 74, 80, and 81. Appx2083-2087; Appx2125-2135.

In response to Honeywell, Daikin referred again to Omure. Appx2456; Appx2459. Mexichem proposed that the Examiner institute a rejection based on Omure. Appx8608 (“[I]t is asserted that the Examiner could institute rejection of claims 1, 2, 4-12, 15-17, and 20-81 as obvious under 35 U.S.C. § 103(a) over Inagaki in view of Omure.”).

The Examiner maintained the initial rejections, and issued a 58-page Right of Appeal Notice that did not mention Omure. Appx2548-2605. Honeywell appealed to the Board. Appx2606-2608. Mexichem did

not appeal the Examiner's failure to adopt its rejection based on Omure. *See* 37 C.F.R. § 41.61(a)(2).

C. The Board's Decision

After briefing and a hearing, the Board affirmed all of the Examiner's rejections. Appx0049.

Originally and as amended, all claims of the '366 patent depend from claim 1. At the Board, the claims were organized in ten groups for argument and analysis. Group I includes claim 1. For Groups II through X, Mexichem's and Daikin's arguments, and the Examiner's and Board's analysis, focused on the limitations added by the dependent claims. The chart below lists the groups for the Court's benefit. With one exception, Honeywell's arguments in this appeal focus on the Board's rejection of the Group I claims, and thus go to all claims at issue. Argument III, below, concerns Groups VI and X. Those claims are reproduced on this brief's inside-back cover.

GROUP	CLAIMS
I	1, 3, 5-6, 8, 11-16, 18-20, 23-25, 31-33
II	2, 9, 10, 58, 59
III	21
IV	22

V	71-74, 80-81
VI	36-37, 46-49, 75
VII	61-64
VIII	65-68
IX	4, 7, 17, 26, 34, 35
X	70

1. Affirmance of Examiner’s Rejections of Group I Claims (1, 3, 5, 6, 8, 11-16, 18-20, 23-25, and 31-33).

The Group I claims were argued and analyzed together based on the Examiner’s similar rejections—for obviousness in light of Inagaki in view of Magid, Acura and “Patentee’s Admissions,” or Bivens. Appx0014. The Board found that Inagaki taught that HFO-1234yf was a known refrigerant with “good COP and good freezing effect with no destructive effects on the ozone layer.” Appx0018. The Board also found that certain properties, including miscibility and toxicity, were “inherent” to the refrigerant, Appx0019, and that even though HFO-1234yf was expected to be too toxic, flammable, and reactive to use in commercial refrigeration systems, those expectations were merely “tradeoff[s]” that would not dissuade a skilled artisan from using HFO-1234yf. Appx0020.

The Board found that Inagaki did not describe any particular lubricant, Appx0021, but that it would have been obvious to use HFO-

1234yf (one of Inagaki's 30 compounds) with known lubricants, including PAGs. Appx0022. As to the unpredictability of miscibility and stability, the Board found that these properties were inherent characteristics of HFO-1234yf, Appx0023, and even if they were unpredictable, were "routinely tested." Appx0024.

Next, the Board considered Honeywell's evidence of unexpected results, which showed stability testing of a PAG lubricant with various HFO refrigerants. While the Examiner had essentially ignored Honeywell's stability testing because it "do[es] not contradict the fact that the stability is an inherent property of the refrigerant/lubricant pair," the Board disagreed and considered that evidence. Appx0029.

In contrast to the Examiner's rejections, moreover, the Board relied explicitly on Omure. Omure is a Japanese patent, filed in 1991 and published in 1993, which describes a "zero-ODP refrigerant" which "consists of 2-trifluoromethyl-3,3,3-trifluoropropene." Appx5110-5117. That refrigerant is not the claimed HFO-1234yf refrigerant, nor is it any of the 30 compounds in Inagaki. Omure states that the refrigerant "has superior intersolubility to PAG-based (polyalkylene glycol-based) oil, polyester-based oil, etc. [and] relatively superior thermal stability."

Appx5113(¶14); *see* Appx0030 (quoting Omure ¶14). The Board agreed with Honeywell that “stability of HFO-1234yf in PAG would not have been expected... because the evidence taken as a whole shows individual refrigerants are not predictable as to their properties under the same or similar conditions.” Appx0030. Thus, even though Omure showed that a certain mixture of one unsaturated refrigerant with a PAG was stable, Honeywell’s evidence showed that other mixtures of HFOs with a PAG were not stable, and stability was therefore unpredictable.

After finding that “stability of HFO-1234yf in PAG would not have been expected,” however, the Board went on to weigh that unpredictability against Honeywell—again, relying on Omure:

Omure’s statement that another HFO compound, also having a double bond and highly reactive fluorine atoms, shows superior thermal stability is a fact that we weigh against Dr. Chamber’s assertion that the results of HFO-1234yf in PAG were necessarily unexpected. Rather, the evidence presented by Patent Owner as a whole shows the unpredictability of how various refrigerants would have reacted with various lubricants. Thus, as evidenced by Omure, *the skilled artisan would no more have expected failure with respect to the stability of combining hydrofluoroolefins with PAG than would have expected success.*

Appx0031. The Board then concluded that Honeywell’s stability testing “when weighed in light of the evidence of routine testing and overall

unpredictability as to stability in the art, is not persuasive evidence of unexpected results.” Appx0031.

Despite relying on Omure to sustain rejections by the Examiner that did not rely on or even mention Omure, the Board did not enter a new ground of rejection. Instead, it stated in a footnote that Mexichem’s and Daikin’s pleadings gave Honeywell sufficient notice:

Requesters identify the teachings of Omure in Requesters’ Comments ... and in Requester’s Comments filed after the Action Closing Prosecution Accordingly, Patent Owner was on notice prior to briefing in this appeal as to Omure’s teachings as evidence of the state of the art at the time of the invention.

Appx0011-0012(n.14).

2. Affirmance of Rejections of Other Dependent Claims.

The Board separately analyzed Groups II through X, starting with its analysis of independent claim 1. Appx0008-11; Appx0013-34. Only the Board’s separate analysis of Group VI and X is challenged here.

Group VI’s claims (36, 37, 46-49 and 75) require that (1) the composition includes HFC-32, HFC-152a, propane, hexane, or octane, and (2) the composition has a maximum GWP of 150 or 75. The Board found that Inagaki taught combining HFO-1234yf with HFC-32 or HFC-152a, and that even though those refrigerants had substantially higher GWP

than HFO-1234yf, the skilled artisan would optimize the amounts of the refrigerants “to take advantage of the environmentally friendly aspects of Inagaki’s refrigerants.” Appx0041. The Board made no finding that one of skill in the art would have known the GWP of HFO-1234yf or how one of skill in the art would go about calculating it.

Group X (claim 70 only) recites claim 1’s composition, plus an additional ingredient, and that the composition is “nonflammable”:

The composition of claim 1 further comprising one or more of difluoromethane (HFC-32), difluoroethane (HFC-152a), propane, hexane, and octane and wherein said composition is nonflammable.

Appx2651. Although the Board made no finding whether one of skill in the art would know the flammability of HFO-1234yf, it nonetheless held that claim 70 was simply a matter of routine optimization. The Board held that HFO-1234yf was inherently “of low flammability,” and that it was “of no moment” that Inagaki disclosed other flammable refrigerants. Appx0048. Thus, the Board held that it would have been obvious to combine HFO-1234yf with refrigerants of “substantially higher flammability,” and that the skilled artisan would optimize the amounts of each refrigerant to minimize flammability. Appx0049.

SUMMARY OF THE ARGUMENT

I. Omure formed no part of any of the Examiner's obviousness rejections. Omure was not part of any ground on which the Examiner instituted reexamination, nor was Omure mentioned even once in the Examiner's 100+ pages of decisions. Yet the Board relied explicitly on Omure as part of its obviousness analysis. By relying on a new reference and new reasoning to sustain the Examiner's rejections, the Board relied on a "new ground" of rejection without giving Honeywell the required notice and opportunity to respond. The Board's decision must therefore be vacated and remanded.

II. The Board's obviousness analysis of Group I (and thus of all claims) relied on improper hindsight at two steps. *First*, the Board held the undisputed unpredictability in the field against Honeywell, and failed to provide any rational reason why a person of ordinary skill in the art would have selected HFO-1234yf and PAG lubricant for testing. *Second*, largely based on an unduly restrictive conception of the "nexus" requirement, the Board failed to give due weight to Honeywell's objective evidence of nonobviousness.

III. At a minimum, the Board’s decision invalidating claims 36, 37, 46-49, 70, and 75 must be reversed. The Board held that those claims were merely obvious claims to routine “optimization” of claimed properties. The Board improperly did so without any predicate finding—or any basis for any predicate finding—that one of ordinary skill in the art would have recognized those properties as result-effective variables in the first place.

STANDARD OF REVIEW

This Court reviews the Board’s legal determinations *de novo* and factual findings for substantial evidence. *Kennametal, Inc. v. Ingersoll Cutting Tool Co.*, 780 F.3d 1376, 1381 (Fed. Cir. 2015). “Substantial evidence” means “such relevant evidence as a reasonable mind might accept as adequate to support a conclusion.” *Consol. Edison Co. v. NLRB*, 305 U.S. 197, 229 (1938). “Whether the Board relied on a new ground of rejection is a legal question,” reviewed *de novo* on appeal. *In re Stepan Co.*, 660 F.3d 1341, 1343 (Fed. Cir. 2011). “Obviousness is a question of law based on underlying findings of fact.” *In re Kubin*, 561 F.3d 1351, 1355 (Fed. Cir. 2009).

ARGUMENT

I. The Board Improperly Relied on a New Ground of Rejection to Sustain the Examiner’s Obviousness Rejections, Without Notice to Honeywell.

“[C]itation by the board of a new reference . . . and reliance thereon to support a rejection” is plainly a “new ground of rejection.” *In re Biedermann*, 733 F.3d 329, 338 (Fed. Cir. 2013) (internal quotation marks omitted, citing *In re Boon*, 439 F.3d 724, 727-28 (C.C.P.A. 1971)). Though the Examiner did not rely on, or even mention Omure, the Board explicitly relied on Omure to hold all claims at issue here obvious. The Board’s reliance on a new ground of rejection, without notice to Honeywell, cannot stand.

A. Patentees in Reexaminations are Entitled to Notice and an Opportunity to Respond Where the Board Relies on a New Ground of Rejection.

Under 35 U.S.C. § 6, the Board performs trial and appellate functions. The Board’s “[r]eview” of examiners’ reexamination decisions is an appellate function. *Id.* § 6(b).^{*} The Examiner decides patentability in the first instance, and the Board’s role on appeal is “limited to review of the examiner’s decisions during prosecution.” *Stepan*, 660 F.3d at 1344

^{*} The same is true of the pre- and post-AIA versions of § 6.

(citing 35 U.S.C. § 6(b)). The Board may affirm, reverse, and/or remand on the basis of the Examiner's grounds of rejection. 37 C.F.R. §§ 41.77(a), 41.50(a). If, however, the Board decides that claims should be cancelled for reasons the Examiner did *not* rely upon, the Board must formally issue a "new ground of rejection," and must allow the patent owner either to reopen prosecution or request rehearing on the new grounds. 37 C.F.R. §§ 41.77(b), 41.50(b).

This Court's precedent is clear that where the Board relies on a new ground of rejection, but fails to identify it as such, the Board has run afoul of the regulations and violated the patentee's due process rights. The patentee has been deprived of notice and an opportunity to respond, and the Board's decision cannot stand. *Biedermann*, 733 F.3d at 336-37; *Rambus, Inc. v. Rea*, 731 F.3d 1248, 1255 (Fed. Cir. 2013); *In re Leithem*, 661 F.3d 1316, 1319 (Fed. Cir. 2011); *Stepan*, 660 F.3d at 1344-45; *In re Kumar*, 418 F.3d 1361, 1367 (Fed. Cir. 2005); *In re Waymouth*, 486 F.2d 1058, 1061 (C.C.P.A. 1974).

Those decisions apply longstanding principles of due process and administrative procedure, which require agencies such as the Patent Office to follow their own rules and to provide notice and an opportunity

to be heard before adjudicating a party's rights. *See, e.g., Armstrong v. Manzo*, 380 U.S. 545, 552 (1965); *Rodale Press, Inc. v. F.T.C.*, 407 F.2d 1252, 1256-57 (D.C. Cir. 1968). The Patent Office is subject to the Administrative Procedure Act, *Dickinson v. Zurko*, 527 U.S. 150, 154 (1999), which entitles parties in agency adjudications to timely notice of “the matters of fact and law asserted,” 5 U.S.C. § 554(b), the “opportunity for ... the submission and consideration of facts [and] arguments ... [and] hearing and decision on notice,” *id.* § 554(c), and opportunity for rebuttal and cross-examination “as may be required for a full and true disclosure of the facts.” *Id.* § 556(d)-(e). On judicial review, agency decisions issued “without observance of procedure required by law” must be set aside. *Id.* § 706(2)(D); *see also Stepan*, 660 F.3d at 1343 (Where the applicant has not had “a fair opportunity to litigate the Board’s actual basis of rejection, the administrative validity proceedings before the [PTO] should be allowed to continue.”).

B. The Board’s Reliance on Omure was an Improper New Ground of Rejection.

Whether the Board has applied a “new ground” of rejection depends on a comparison of the Board’s reasoning with the Examiner’s. *See, e.g., Biedermann*, 733 F.3d at 336 (“whether the Board and the ex-

aminer properly relied on the same articulated reasoning and factual underpinnings... or whether the Board made new findings and adopted different reasons"); *Leithem*, 661 F.3d at 1320. The Board may "make additional findings of fact based upon the Board's own knowledge and experience to 'fill in the gaps' that might exist in the examiner's evidentiary showing." *Id.* at 1319. But "the Board's power to do so is construed narrowly and when reliance upon such facts changes the thrust of the rejection," it has adopted a new ground of rejection. *Id.*

While some fact patterns present close questions, "citation by the board of a new reference ... and reliance thereon to support a rejection" is plainly a "new ground of rejection." *Biedermann*, 733 F.3d at 338 (internal quotation marks omitted).

1. The Board Relied on Omure.

In this case, the Board plainly relied on Omure in affirming the Examiner. In its discussion of objective evidence ("secondary considerations"), the Board stated, "[h]owever, Omure's statement that another HFO compound, also having a double bond and highly reactive fluorine atoms, shows superior thermal stability is a fact that we weigh against Dr. Chamber's assertion that the results of HFO-1234yf in PAG were

necessarily unexpected.” Appx0031. The Board concluded that “as evidenced by Omure, the skilled artisan would no more have expected failure with respect to the stability of combining hydrofluoroolefins with PAG than would have expected success.” *Id.*

The Board also explicitly considered Omure in discounting Honeywell’s evidence of unexpected results, as further discussed below. Appx0033; *Statement of the Case* § I.B.2, *infra*. However, Dr. Chambers’ declaration was not limited to “unexpected results.” He also opined that “a person of ordinary skill in the art at the time of Honeywell’s invention would have expected the combination of HFO-1234yf with a PAG lubricant to be an unstable combination.” Appx0302(¶15). Dr. Chambers thus concluded that “it would not have been obvious to a person of ordinary skill in the art at the time of Honeywell’s invention that a stable heat transfer composition could be formed from the combination of HFO-1234yf and PAG.” *Id.*

The Board’s decision essentially finds that a person of ordinary skill in the art would have had a reasonable expectation of success in forming a stable heat transfer composition from HFO-1234yf and PAG. Yet no record evidence—other than Omure—even arguably relates to

that issue. Omure is the *only* reference that discloses *any* unsaturated HFO with *any* identified lubricant.

The Board's logic makes clear that Omure was the basis for the Board's rejections. First, the Board "agree[d] with Patent Owner that Inagaki does not describe any particular [lubricant]." Appx0021. Next, the Board recognized that PAG is a known type of lubricant, and even though "the secondary references disclosing lubricants are directed to saturated hydrofluorocarbons," "Inagaki itself would have suggested combining unsaturated HFO-based refrigerants with the lubricants disclosed in the secondary references," "because the combination of lubricants and an unsaturated HFO-based refrigerants is described in Inagaki." Appx0022-0023. Moreover, based on a single sentence in Inagaki, the Board determined that Inagaki taught "compatibility with lubricants." Appx0024.

Although the HFOs described in Inagaki would have been expected to be toxic, flammable, and reactive, Appx0365-0366(¶¶9-10), Appx0366-0367(¶13), Appx0371-0372(¶27), Appx0299(¶5), Appx0300-0301(¶10), Appx0466(¶11), Appx0613-0614(¶¶4-5), Appx0618(¶24), Appx1815(¶5), and one of skill in the art would have expected HFOs to

react with PAGs, Appx0299-0302(¶¶5-15), the Board concluded that this combination would have been obvious, largely because of Inagaki's single sentence describing "compatibility" with *unknown* lubricants. Without Omure, the Board's decision thus lacks a logical step, as there is no expectation of success—or motivation to combine for that matter—in achieving a heat transfer composition of HFO-1234yf with a PAG lubricant. To be clear, the Board's decision is erroneous on the merits, with or without Omure. *See Argument §§II-III, infra*. For present purposes, the point is that the Board necessarily relied on Omure.

Where, as here, the Board relies on a new reference to hold patent claims obvious, the Board relies on a new ground of rejection to which Honeywell had a right to notice and opportunity to respond.

2. Honeywell Was Not Given Proper Notice or an Opportunity to Respond.

The Board's statement that "Patent Owner was on notice prior to briefing in this appeal as to Omure's teachings as evidence of the state of the art at the time of the invention," Appx0011-0012(n.14), was erroneous.

Due process, the APA, and reexamination regulations foreclose any contention that a requester's unacknowledged arguments constitute

proper notice to the patentee. Whether a ground of rejection is “new” depends on a comparison of the Board’s reasoning with the Examiner’s—not parties’ unadopted arguments. This Court’s precedent has repeatedly confirmed that point. *See Biedermann*, 733 F.3d at 336 (“The articulated reasoning and factual underpinnings of an examiner’s rejection are, thus, essential elements of any stated ground of rejection to which applicants are entitled to notice and a fair opportunity to respond.”); *Stepan*, 660 F.3d at 1344 (“By making and relying on new fact findings regarding an issue *the examiner did not raise*, ... the Board relied on a new ground of rejection.”); *Leithem*, 661 F.3d at 1320 (similar); *Kumar*, 418 F.3d at 1368 (“[T]he Board found facts not found *by the examiner* ... which in fairness required an opportunity for response.”). Here, the Examiner neither relied upon nor acknowledged Omure.

Omure was not part of any ground on which the Examiner instituted reexamination. Appx0242-0252; Appx6204-6216. Nor did the Examiner rely on or acknowledge Omure in its rulings. Mexichem and Daikin both mentioned Omure in later briefing, and Mexichem proposed a rejection based upon Omure. But the Examiner never addressed those comments, and never entered the proposed rejection. Nor did

Mexichem appeal the Examiner's refusal to enter the proposed rejection, though it could have. 37 C.F.R. § 41.61(a)(2). The scope of the appeal to the Board—and thus whether a Board rejection is “new”—turns on the Examiner's reasoning, not a reference that the Examiner never mentioned. *See, e.g.*, MPEP 2666 (“Any request for reconsideration must be in writing and must distinctly and specifically point out each supposed error in the *examiner's action*.”). The MPEP likewise requires in a right of appeal notice that “[t]he examiner's position as to any arguments and comments raised by the patent owner and the third party requester should be clearly set forth, *so that any appeal taken can address the examiner's position* as to the arguments and comments.” MPEP 2673.02. Here, the Examiner did not have a position on Omure, so Honeywell could not address that position.

This case is similar to *Biedermann*, *Rambus*, and *Stepan*, where the Board likewise relied on a new ground of rejection without proper notice to the patentee.

In *Biedermann*, the patentee received greater notice than Honeywell received here, and this Court reversed. The Examiner's answer “made a passing reference” to a machinery handbook, but “neither re-

lied upon nor even noted” its significance. 733 F.3d at 337-38. The Board, however, relied on that handbook and made new factual findings concerning a motivation to combine references. *Id.* at 338. Because the new findings and new reference were not explanatory of, but rather in addition to, the Examiner’s decision, this Court held that the Examiner relied upon a new ground of rejection. *Id.* at 339. Here, not only did the Examiner “neither rely upon nor even note” the Omure reference, he never even “made a passing reference” to it.

In *Rambus*, the Examiner relied upon two prior art references to find the claims obvious. 731 F.3d at 1251. The Board affirmed the Examiner’s obviousness determination, but supplied its own reasons to combine the two references. *Id.* at 1256. This Court held that the Board overstepped its authority because its “findings were completely new” and did not merely “elaborate on the examiner’s findings with ‘more detail.’” *Id.* This Court stressed that the Board “has a procedure for issuing a new ground of rejection,” and that procedure “ensures that appellants have an appropriate opportunity to respond.” *Id.* Because the Board did not follow that procedure, this Court vacated and remanded.

Id. (“We cannot let the Board shortcut this procedure and deprive appellants of their due process rights.”).

In *Stepan*, the Examiner used a prior art reference (“Singh”) to find all claims invalid as anticipated under 35 U.S.C. § 102(b), or alternatively obvious. 660 F.3d at 1343. On appeal, the Board affirmed the Examiner’s obviousness rejection, but treated Singh as prior art under § 102(a), instead of § 102(b). *Id.* In relying on Singh as § 102(a) prior art to support the obviousness rejection, the Board determined that Stepan’s Declaration failed to remove Singh as a § 102(a) reference. *Id.* The *Examiner*, however, had “never raised the question whether Singh was § 102(a) prior art, never addressed that argument, never expressed any concerns as to any alleged deficiencies with the Declaration, and never issued a rejection using Singh as § 102(a) prior art.” *Id.* This Court vacated and remanded the Board’s decision because “Stepan did not have prior notice of the Board’s intent to craft and rely on new findings” and thus his “notice rights were violated.” *Id.* at 1346 (citing 5 U.S.C. § 554(b)(3) and 35 U.S.C. § 6(b)).

Consistent with *Biedermann*, *Rambus*, and *Stepan*, the Board's decision in this case must be vacated and remanded for reliance on a new ground of rejection without proper notice to Honeywell.

II. The Board Erred in its Consideration of Obviousness.

In addition to the procedural infirmity in the Board's decision, its analysis of obviousness relied on hindsight. Consistent with the text of 35 U.S.C. § 103, Supreme Court precedent consistently holds that adjudicators must take care to avoid hindsight in an obviousness analysis. *See, e.g., Graham v. John Deere Co.*, 383 U.S. 1, 36 (1966) (objective evidence “guard[s] against slipping into use of hindsight” (internal quotation marks omitted)); *KSR*, 550 U.S. at 421 (cautioning to avoid “hindsight bias and ... arguments reliant on *ex post* reasoning.”). In other words, the Board may not simply march through prior art to locate individual claim elements and declare, in hindsight, that the patented combination was obvious.

One important safeguard against the use of hindsight is the general rule that a patent challenger “must demonstrate ... that a skilled artisan would have had reason to combine the teaching of the prior art references to achieve the claimed invention, and ... would have had a

reasonable expectation of success from doing so.” *In re Cyclobenzaprine Hydrochloride Extended-Release Capsule Patent Litig.*, 676 F.3d 1063, 1068-69 (Fed. Cir. 2012) (internal quotation marks omitted). Another is the requirement that the adjudicator must always consider “secondary considerations” or “objective evidence of nonobviousness” as part of the analysis rather than as an afterthought. The Board’s analysis here ran afoul of both safeguards, and must be reversed.

A. The Board Relied on Improper Hindsight to Find a Motivation to Combine Inagaki with Magid, Bivens, or Acura, With a Reasonable Expectation of Success.

1. The Board Erred in Finding a Motivation to Combine.

The Board’s finding that one of skill in the art would be motivated to combine the unsaturated HFO-1234yf refrigerant of Inagaki with PAG lubricants mentioned in Magid, Bivens, or Acura depends, fundamentally, on an erroneous disregard for the perspective of skill in the art in 2002.

It is undisputed that HFOs, as a class, were thought to be less stable, more reactive, more toxic, and more flammable than saturated HFCs—all of which are highly undesirable properties for refrigerants. Appx0365-0366(¶¶9-10); Appx0366-0367(¶13); Appx0371-0372(¶27);

Appx0299(¶5); Appx0300-0301(¶10); Appx0466(¶11); Appx0613-0614(¶¶4-5); Appx0618(¶24); Appx1815(¶5); Appx4148-4149; Appx0928(n.4); Appx0450-0463; Appx0407-0449; Appx10738(2:28-33); Appx4086(3:13-43). Even Mexichem’s expert, Dr. Corr, confirmed that unsaturated HFCs were known to be more reactive than saturated HFCs. Appx4244:21-4245:5; Appx4245:23-4246:16 (Corr Dep.). Yet the Board ignored these teachings, and assumed either that a motivation to combine existed, or the combination was obvious to try.

This Court has repeatedly recognized that the obvious-to-try framework is rarely appropriate in the chemical field. Compared to the mechanical device in *KSR*, chemical inventions such as Honeywell’s are less predictable and rarely obvious to try. *See, e.g., Eisai Co. v. Dr. Reddy’s Labs., Ltd.*, 533 F.3d 1353, 1359 (Fed. Cir. 2008) (“In ‘chemical arts ... *KSR*’s focus on these ‘identified, predictable solutions’ may present a difficult hurdle because potential solutions are less likely to be genuinely predictable.”); *Sanofi-Aventis Deutschland GmbH v. Glenmark Pharms. Inc., USA*, 748 F.3d 1354, 1360 (Fed. Cir.) (rejecting obvious-to-try argument in the chemical arts), *cert. denied*, 135 S. Ct. 759 (2014); *Pozen Inc. v. Par Pharm., Inc.*, 696 F.3d 1151, 1165-66 (Fed. Cir.

2012) (same); *Leo Pharm. Products, Ltd. v. Rea*, 726 F.3d 1346, 1356 (Fed. Cir. 2013) (same).

In this case, it is undisputed that there were thousands of possible combinations of refrigerants and lubricants, and that the behavior of each combination was largely unpredictable in advance. The following six points are in evidence and uncontradicted:

- At the time of Honeywell's invention, the only fluorocarbon chemicals that had ever been successfully used as commercial refrigerants were saturated compounds. Appx0364(¶7).
- Unsaturated compounds were known as a class to be more flammable, reactive, and toxic than saturated compounds. Appx0365-0372(¶¶9-10, 13, 27); Appx0299-0301(¶¶5-6, 10); Appx0466(¶11); Appx0613-0618(¶¶4-5, 24); Appx1815(¶5); Appx4244:21-4245:5; Appx4245:23-4246:16 (Corr Dep.).
- PAG lubricants were known *not* to work with some HFCs and HFOs. Appx0370(¶21); Appx0300-0302(¶¶8-15); Appx0465-0468 (¶¶10-15); Appx0617-0618(¶23); Appx1814-1815(¶¶4-5).

- PAG lubricants were known to have drawbacks such as hygroscopicity and instability. Appx1814-1815(¶¶4-5); Appx10718(1:37-54); Appx10725; Appx6017(1:44-51).
- The miscibility of a lubricant with a refrigerant was not predictable in advance and required testing. Appx0370(¶21); Appx0465-0469(¶¶10-17); Appx0617-0618(¶23).
- At the time of Honeywell's invention, *thousands* of possible compounds were available for consideration as more environmentally friendly heat transfer compositions. Appx0365(¶9).

Thus, rather than a “finite number of identified, predictable solutions,” *KSR*, 550 U.S. at 421, there were numerous potential, unpredictable solutions where one of skill would have had to “‘throw[] metaphorical darts at a board’ in hopes of arriving at a successful result.” *Leo*, 726 F.3d at 1357. This case is thus like many other chemical cases where this Court has squarely rejected any contention that the “obvious to try” framework applies. The universe of possible “solutions” in 2002 was neither “finite” nor “predictable.” Tellingly, if it was, surely another government agency or company would have discovered Honeywell's invention sooner than ten years after the publication of Inagaki.

As to motivation to combine, this Court has made clear that “conclusory statements” are not enough; “there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.” *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006). In other words, there must be some rational “glue to combine [prior art] references.” *InTouch Techs., Inc. v. VGO Commc’ns, Inc.*, 751 F.3d 1327, 1348 (Fed. Cir. 2014). Here, however, the Board both glossed over the unpredictability of the art, and held that unpredictability *against* Honeywell. Although the patent claims combinations of HFO-1234yf with PAG lubricant, the Board largely ignored the combination aspect of the patent and treated Honeywell’s patent as if the discovery was simply the inherent properties of HFO-1234yf by itself. Thus, for example, the Board reminds the parties that “the properties of the particular refrigerants are inherent to the *refrigerant*, whether specifically disclosed or not.” Appx0019 (original emphasis). Perhaps true, but irrelevant, as the claims are to refrigerant-lubricant *combinations*, and it is undisputed that the behavior of refrigerants and lubricants *in combination* is generally unpredictable in advance.

On that point, the Board reasoned that, so long as combinations of refrigerants and lubricants could be tested by routine methods, every refrigerant-lubricant combination is necessarily obvious:

Thus, if the properties of refrigerants were all recognized as being unpredictable, and yet routinely tested in order to determine whether a particular compound would be suitable for a given application, identification of these properties for known refrigerants would have been obvious unless the needed testing was outside of the skill of the ordinary artisan. Patent Owner has not shown that testing for miscibility and stability of a refrigerant/lubricant pair was anything other than routine in the art.

Appx0024. That reasoning is at the core of the Board's analysis, and it is backwards in several respects.

First, there is no requirement that the inventor of a nonobvious combination must also invent a novel method of testing for advantages of the combination. The clinical efficacy of drugs is often tested by conventional methods, but that fact does not render pharmaceutical combination patents presumptively obvious.

Second, “[w]hether a skilled artisan would be motivated to make a combination includes whether he would select particular references in order to combine their elements.” *WBIP, LLC v. Kohler Co.*, No. 2015-1038, --- F.3d ---, 2016 WL 3902668, at *12 (Fed. Cir. July 19, 2016).

The Board skips over that step entirely. Where, as here, it is undisputed that there are thousands of possible combinations, the availability of routine testing methods to figure out which combinations work does not answer the question of which combinations should be selected for testing in the first place. In that respect, the Board depends on hindsight.

Although the Board refers elsewhere to Inagaki's discussion of the properties of various compounds, *e.g.*, Appx0017-0018, that discussion likewise fails to explain why a skilled artisan would choose an HFO in the first place. Notwithstanding Inagaki's references to desirable properties the group of 30 refrigerants might have had, its only specific discussion of HFO-1234yf compares it to another refrigerant (HFO-1243zf, Inagaki's "Embodiment 1") that undisputedly has *unacceptable* toxicity and flammability for air conditioning applications. Appx0367-0368(¶¶14-15); Appx0613-0614(¶5). And NASA considered other unsaturated compounds disclosed in Inagaki and found them all unacceptably "reactive." Appx0407-0449.

Neither Inagaki nor the Board explains away those concerns with unsaturated compounds or suggests why a person of skill in the art would be motivated to test any compound referred to in Inagaki with a

lubricant. Inagaki is owned by petitioner-appellee Daikin, and sat abandoned for ten years before Honeywell's discovery. Again, it is undisputed that numerous prior art references cautioned that unsaturated compounds, as a class, were unsuitable for commercial applications. Inexplicably, the Board dismissed those concerns as "tradeoff[s]," which "the skilled artisan would have recognized." Appx0020. Rather, the evidence in this case was unequivocal that reactivity, toxicity, and flammability were disqualifying factors, not "tradeoffs." Appx0367(¶14); Appx0613-0614(¶¶4-9); Appx2766-2807; Appx2814-2821; Appx4148-4149; Appx10738(2:28-33). HFO-1225zc, a compound within the general formula of Inagaki, is generally too toxic to be used in air conditioning. Appx0367(¶14). Any "tradeoff[s]" would have led the skilled artisan to avoid the HFOs altogether—which is why the art consistently taught to avoid unsaturated compounds. And in any event, nowhere does the Board explain how a skilled artisan would have known what those properties actually were to make the purported "tradeoffs" in the first place.

Third, the Board's statement that "Patent Owner has not shown that testing ... was anything other than routine in the art," Appx0024,

is one of many statements in the Board's opinion suggesting that the Board improperly placed the burden of proof on Honeywell to *disprove* obviousness, rather than the other way around. *See also, e.g.*, Appx0026 (“[T]he Patent Owner has the burden to show a ‘nexus’...”); Appx0031 (“Patent Owner has the burden of showing by at least a preponderance of the evidence that the results presented would have been unexpected to render combined teachings non-obvious.”); Appx0034 (“[W]e do not find that Patent Owner’s evidence of secondary consideration[s] persuasively supports a determination of non-obviousness...”). *Inter partes* reexaminations are “adversarial” proceedings concerning “the claims of an issued patent,” *Leo*, 726 F.3d at 1358 (emphasis omitted). In such adversarial proceedings, the burden of persuasion of obviousness “never shifts to the patentee.” *In re Magnum Oil Tools Int’l, Ltd.*, No. 2015-1300, --- F.3d ----, 2016 WL 3974202, at *6, *8 (Fed. Cir. July 25, 2016) (reversing where the Board’s IPR decision was “replete with examples where, ... the Board improperly shifted the burden to Magnum to disprove obviousness.”).

2. The Board Erred in Finding a Reasonable Expectation of Success in Combining Inagaki with Magid, Bivens, or Acura.

The Board also erred in finding that skilled artisans would have had a reasonable expectation of success in combining HFO-1234yf with PAG lubricants.

It is undisputed that the compatibility of PAG lubricants, and lubricants in general, with refrigerants was known to be unpredictable and could only be determined through testing. Appx0370(¶21); Appx0300-0302(¶¶8-15); Appx0465-0466(¶¶10-11); Appx0617-0618(¶23); Appx1814-1815(¶¶4-5). For instance, HFO-1243zf (one of the five examples in Inagaki) forms dimers in the presence of PAG lubricants, but HFO-1234yf does not. Appx0569(¶26); Appx0608(Table 3). Dimers are the result of two molecules of the HFO reacting with one another, and may adversely affect the operation of the air conditioning system. Appx0569(¶26). One of skill thus would not have had a reasonable expectation of success in developing a workable composition from these two reactive compounds. The Board recognized as much in an *inter partes* review on a different patent, rejecting a similar argument from Mexichem for treating one HFC-PAG combination as necessarily repre-

sentative of all such combinations. *See Mexichem Amanco Holdings S.A. de C.V. v. Honeywell Int’l Inc.*, IPR2015-01309, Paper No. 8, at 17 (P.T.A.B. Dec. 9, 2015) (institution decision) (“Petitioner does not explain sufficiently why the disclosure in Omure of a single, specific HFC that works well with PAG- and polyester-based lubricants would suggest to one of skill in the art that *all* HFCs, or at least the HFCs of Inagaki and Kruse, would work well with the same lubricants.”).

In this case, the record evidence shows not only that the compatibility of HFOs and PAG lubricants was unpredictable without testing, but that that one of skill in the art would expect that HFOs and PAG lubricants to react adversely with each other. Appx0300-0302(¶¶8-15). As unsaturated compounds, HFOs were considered unstable and reactive. Appx0364-0367(¶¶7, 9-10, 13); Appx0613-0614(¶¶4-5); Appx0618(¶24); Appx4148-4149 (initial screening “ruled out any compounds identified as unacceptably ‘reactive’ including those containing functional groups such as double bonds”); *see also* Appx4244:21-4245:5; Appx4245:23-4246:16 (Corr Dep.); *Statement of the Case § I.C, supra*.

Additionally, PAGs can form acids in the presence of moisture, resulting in “corrosion of the refrigeration system, and the formation of

intractable sludges.” Appx10718(1:50-54). In his unrebutted declaration, Dr. Chambers explained how HFOs and PAGs would have been expected to react, accompanied by specific mechanisms of their reaction. Appx0300-0302(¶¶8-14); Appx0355-0356. For instance, acids can assist the removal of a fluoride from an HFO, resulting in the dimerization of the HFO. Appx0301(¶12); Appx0356(fig. 3).

Given the understanding of those of skill in the art, one would certainly not have expected that PAGs would simply work with any or all HFOs, or HFO-1234yf in particular. Rather, one of skill in the art would have altogether avoided this combination of reactive compounds. *See W.L. Gore & Assocs. v. Garlock, Inc.*, 721 F.2d 1540, 1552 (Fed. Cir. 1983) (“[P]roceed[ing] contrary to the accepted wisdom of the prior art... is strong evidence of nonobviousness.”) (citing *United States v. Adams*, 383 U.S. 39, 52 (1966)).

The Board properly concluded that the evidence as a whole showed “the unpredictability of how various refrigerants would have reacted with various lubricants.” Appx0031. However, the Board then erroneously concluded that even though “the skilled artisan would no more have expected failure with respect to the stability of combining

hydrofluoroolefins with PAG than would have expected success,” *id.*, the combination of a thought-to-be-reactive HFO and an unstable PAG would have been obvious.

The Board’s conclusion about the unpredictability of “the stability of combining hydrofluoroolefins with PAG,” Appx0031, logically means that a skilled artisan would not have expected success in combining an HFO with a PAG. There can be no reasonable expectation of success without some indication in the prior art of which HFOs might be stable and miscible in combination with a PAG. *See Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006) (“To have a reasonable expectation of success, one must be motivated to do more than merely to vary all parameters or try each of numerous possible choices until one possibly arrived at a successful result, where the prior art gave either no indication of which parameters were critical or no direction as to which of many possible choices is likely to be successful.”). Without some expectation of success, the combination cannot be obvious. *Cyclobenzaprine*, 676 F.3d at 1068-69. The Board found that there was no such indication, yet still found that the combination was obvious.

B. The Board Improperly Considered Objective Evidence of Nonobviousness.

“Secondary considerations,” or “objective indicia of nonobviousness,” constitute one of the four *Graham* factors and are an indispensable part of any obviousness analysis. *WBIP*, 2016 WL 3902668, at *5; *Transocean Offshore Deepwater Drilling, Inc. v. Maersk Contractors USA, Inc.*, 617 F.3d 1296, 1305 (Fed. Cir. 2010); *Mintz v. Dietz & Watson, Inc.*, 679 F.3d 1372, 1379 (Fed. Cir. 2012). Objective evidence “play[s] an important role as a guard against the statutorily proscribed hindsight reasoning in the obviousness analysis. Indeed, we have held that ‘evidence of secondary considerations may often be the most probative and cogent evidence in the record.’” *WBIP*, 2016 WL 3902668, at *5; *see also Graham*, 383 U.S. at 36; *Cyclobenzaprine*, 676 F.3d at 1076 n.3. Despite the long-recognized importance of objective evidence, this Court has frequently needed to remind trial courts, agencies, and litigants that such evidence may not be treated as an “after-the-fact consideration[] or relegat[ed] to ‘secondary status’” in an obviousness analysis. *Cyclobenzaprine*, 676 F.3d at 1078; *see also WBIP*, 2016 WL 3902668, at *5 (“[W]e have repeatedly stressed that objective considerations of non-obviousness must be considered in *every* case.”) (original emphasis, cit-

ing cases); *Nike, Inc. v. Adidas AG*, 812 F.3d 1326, 1340 (Fed. Cir. 2016) (reversing Board for failure to consider objective evidence); *Leo*, 726 F.3d at 1357–58 (same); *OSRAM Sylvania, Inc. v. Am. Induction Techs., Inc.*, 701 F.3d 698, 709 (Fed. Cir. 2012) (reversing district court).

Despite this Court’s repeated emphasis, empirical analyses indicate that the Board generally holds objective evidence in low regard. *See, e.g.*, M. Sherby, *Trends and Strategies for Addressing Secondary Considerations in PTAB Proceedings*, PTAB Trials Blog (May 3, 2016) at <http://www.ptabblog.law/?p=270> (of 1,001 final Board decisions, objective evidence was substantively addressed in 192, and a patentee’s objective-evidence-based argument prevailed in one); K. Moran et al., *A Review of PTAB Cases Involving Secondary Considerations*, Law360.com (July 31, 2015) (of 3,010 institution and final written decisions, objective evidence substantively addressed in 162, and patentee succeeded in 2), at <http://www.law360.com/articles/685235>; D. Agopso-wicz, *The PTAB Yet Again Finds Evidence of Secondary Considerations Insufficient* (Mar. 11, 2015), at <http://bit.ly/2atxpCA>.

This case is yet another example of the Board’s inappropriately low regard for objective evidence. Under a proper analysis, that evi-

dence should have been compelling. In this undisputedly unpredictable area of the chemical arts, Honeywell succeeded where multinational chemical companies, trade organizations, foreign governments, NASA, and others had failed for decades because Honeywell looked where the prior art consistently taught not to look. As noted above, Inagaki was published in 1992, and Daikin, one of the re-examination requesters in this case, owns the Inagaki application and employed all four named inventors. Appx5987. If Inagaki's undifferentiated discussion of 30 compounds would have taught a person of ordinary skill in the art in 2002 what the Board now says it does, then surely Daikin would have acted on that teaching and discovered the combination of HFO-1234yf and PAG lubricant sometime in the ten years between Inagaki's publication and Honeywell's invention. Instead, Honeywell is on pace to sell 20 *million* pounds of HFO-1234yf by the end of 2017, and Honeywell's competitors now wish to exploit that invention by using hindsight to invalidate Honeywell's patent. Nonetheless, the Board concluded in 2015 that Honeywell's invention was simply a matter of routinely testing a compound disclosed in 1992 with various lubricants. In that regard, the Board's analysis resembles *Leo*, another chemical arts case where the

Board's dismissal of objective evidence in an *inter partes* reexamination required reversal. 726 F.3d at 1357-59. The same is true here.

1. The Board Improperly Evaluated Evidence of Unexpected Stability.

It is undisputed that (1) HFO-1234yf is part of a group—unsaturated hydrocarbons—that were known as a class to be unstable and reactive, Appx0373(¶31), Appx2632, Appx8539, Appx8546, and (2) PAG lubricants were known as a class to be reactive. Appx0370(¶21); Appx0467-0468(¶¶12-14); Appx1814-1815(¶¶4-5). Yet, it is also undisputed that Honeywell's patented combination of HFO-1234yf with PAG lubricants is stable in combination. Honeywell presented the results of stability testing to demonstrate that HFO-1234yf has superior stability in combination with a PAG lubricant, as compared to other HFOs. Appx0563-0608. Each column below represents a different stability test.

TABLE 3

	Fluoride	TAN	Dimers
1243zf	2.8	1.6	Yes
1234yf	75	2.55	No
1234ze	2166	5	No
1225yez	216	2.2	No
1261yf	160,000	85	Not possible to measure

Appx0568-0569(¶¶23-26); Appx0608(Table 3). The Board improperly dismissed these results as unpersuasive by misinterpreting the results and improperly relying on Omure.

First, the Board misinterpreted the stability testing, selectively comparing refrigerants by weighing values individually, rather than considering all of the values and comparing each refrigerant for its overall behavior. As Honeywell explained, these three tests must be considered together, not individually. Appx2634. When properly viewed as three portions of a single overall stability test, it is clear that HFO-1234yf shows unexpected stability, especially with the closest prior art, HFO-1234ze, its structural isomer. HFO-1234yf has a lower fluoride value than all but HFO-1243zf and a lower Total Acid Number (TAN) (a higher value indicates lower stability) than all but HFO-1243zf and

HFO-1225yez. Appx0569(¶25). Yet HFO-1243zf produces dimers, which would “create components that may have a deleterious effect” on air conditioning systems, whereas HFO-1234yf does not. Appx0569(¶26). And HFO-1225yez has a fluoride value almost three times higher than HFO-1234yf.

Rather than consider these tests in combination, the Board analyzed them individually, noting that “HFO-1225yez also has no dimerization and has a lower TAN value than that of HFO-1234yf, suggesting that lack of dimerization is not a critical factor. Patent Owner has not explained why we should credit the improvement in Fluroide [*sic*] value shown in HFO-1234yf over a lower TAN value and equivalent dimerization of HFO-1225yez.” Appx0032. The Board improperly gave more weight to a 13% decrease in total acid number rather than a 65% decrease in fluoride value. Honeywell did not explain why the Board “should credit the improvement” because it was clear based on the data presented, when properly taken as a whole.

Moreover, HFO-1225yez is not the closest prior art because it is 1) not one of the examples disclosed in Inagaki, and 2) is not a structural isomer of HFO-1234yf. Of the HFOs in Dr. Thomas’ stability testing, all

but HFO-1225yez are disclosed in the examples of Inagaki (with the exception that Inagaki does not describe a particular isomer of HFO-1234ze). Appx5987-5994. HFO-1225yez was included simply because Honeywell had the data on hand. However, of the tested HFOs, HFO-1234ze is the closest prior art because it is a structural isomer of HFO-1234yf. HFO-1234yf and 1234ze both contain the same number of hydrogen, carbon, and fluorine atoms, and can both be written as $C_3H_2F_4$. Therefore, under a proper analysis of unexpected results, HFO-1234yf should be compared to HFO-1234ze. *In re Merchant*, 575 F.2d 865, 869 (C.C.P.A. 1978) (unexpected results must be compared to closest prior art); *see also Eisai Co. v. Dr. Reddy's Labs., Ltd.*, 533 F.3d 1353, 1356–57 (Fed. Cir. 2008) (determining differences between claimed invention and prior art “often turns on the structural similarities and differences between the claimed compound and the prior art compounds”); *In re Chupp*, 816 F.2d 643, 645 (Fed. Cir. 1987) (evidence of unexpected results in comparison to compounds of “close chemical structure” persuasive of nonobviousness).

Next, the Board improperly discounted these results by reference to Omure, to which Honeywell was never given an opportunity to re-

spond. *See Argument § I, supra.* The Board determined that even if Honeywell's results were unexpected—they were—they were not persuasive in view of Omure:

Further, even if the data of Table 3 shows an improvement in stability of HFO-1234yf in PAG over the other tested HFO compounds in PAG because good (if not the best) results were achieved in all (rather than just some) metrics, such is not by itself sufficient to demonstrate unexpected results. That is, the data are insufficient to support the testimony of Dr. Thomas and Dr. Chambers that this improvement would have been unexpected and that the results of combining HFO-1234yf in PAG would not have been obvious. The data is particularly unpersuasive when weighed in light of the overall unpredictability in the art and other HFO compounds in the art having "superior thermal stability" in PAG, as evidenced by Omure.

Appx0033.

However, at the time of the invention, stability of an HFO and a PAG was not merely "unpredictable." Rather, one of ordinary skill in the art would have expected that the combination would be unstable. Appx0371-0372(¶27); Appx0299-0302(¶¶5-15); Appx1814-1815(¶¶4-5). It was entirely *unexpected* that the combination of HFO-1234yf and PAG was not only stable, but also exhibited superior stability as compared to other HFO/PAG combinations.

2. The Board Ignored Evidence of Unexpected Miscibility.

The combination of HFO-1234yf and a PAG lubricant is unexpectedly miscible. The miscibility testing in the record shows that HFO-1234yf and PAG are completely miscible below about 25°C. Appx0566-0568(¶¶13, 20); Appx0578. This unexpected miscibility is especially desirable because if the temperature of complete miscibility is “about the same as or above about the expected temperature in the evaporator, then this provides a good indication that the lubricant/refrigerant pair will be useful in the refrigeration system without the need for an oil separator.” Appx0567(¶17).

Rather than considering this evidence as weighing against obviousness, or even recognizing that miscibility is a property of two substances in combination, the Board wrote it off as an “inherent” property of the refrigerant:

- “The properties discussed by Dr. Bivens, including miscibility and stability of HFO-1234yf with PAG, are inherent characteristics of HFO-1234yf, and the record provides sufficient evidence that the skilled artisan would have used HFO-1234yf with known lubricants, such as PAG.” Appx0023.

- “The miscibility of HFO-1234yf with PAG is an inherent characteristic of HFO-1234yf, and the record provides sufficient evidence that the skilled artisan would have used HFO-1234yf with known lubricants, such as PAG. With routine testing, the skilled artisan would have had a reasonable expectation that Inagaki's unsaturated HFO compounds were miscible either with mineral oils and alkylbenzenes or alternatively with PAG and POE.” Appx0038.

The Board’s dismissal of unexpected miscibility as an “inherent” property of HFO-1234yf necessarily disclosed in Inagaki is erroneous in at least two respects.

First, miscibility is not an inherent property of HFO-1234yf; it is undisputedly a property of two substances in *combination*. Appx0370(¶21); Appx0465-0466(¶10); Appx0564-0565(¶9). In other words, HFO-1234yf is not inherently “miscible” or “immiscible”; it is only either of those things in combination with another substance, and it is undisputed that the miscibility of HFO-1234yf with other substances could not be predicted in advance. Indeed, as record evidence (Dr.

Thomas's testing) shows, the miscibility of HFO-1234yf and *PAG lubricants* varies depending on the particular PAG. Appx0580-0583.

Obviousness rejections based on properties that are “inherent” but unknown are disfavored, because “[o]bviousness cannot be predicated on what is unknown.” *In re Rijckaert*, 9 F.3d 1531, 1534 (Fed. Cir. 1993). Inherency is a doctrine “originally rooted in anticipation.” *PAR Pharm., Inc. v. TWI Pharm., Inc.*, 773 F.3d 1186, 1195 (Fed. Cir. 2014). A party relying on inherency to support an obviousness argument “must ... meet a high standard ... the limitation at issue *necessarily* must be present, or the natural result of the *combination* of elements explicitly disclosed by the prior art.” *Id.* at 1195-96. It is undisputed that the possible combinations here were numerous, and the properties of each could not be predicted in advance. Thus there cannot be an expectation of success in achieving claimed limitations, specifically miscibility, where the skilled artisan knew that such miscibility was unpredictable.

Second, even where it may be “obvious to experiment,” there must still be a reasonable expectation of success. *Leo*, 726 F.3d at 1357. In *Leo*, this Court found the claims at issue nonobvious where “the storage stability of these formulations cannot be determined based on a few

days of work,” such that “an artisan could have spent years experimenting without success.” *Id.* The Board’s writing off of miscibility as “inherent” and discoverable through routine testing is unsupportable. Here, the evidence is undisputed that miscibility could not be predicted in advance, and had to be tested, not only for each individual combination, but for different proportions of that combination at multiple temperatures. Appx0370(¶21); Appx0564-0568(¶¶9-18); Appx0465-0469(¶¶10-17). For instance, one miscibility study in the record of ten refrigerants with fourteen lubricants, Appx0464-0465(¶¶1-7), Appx0467(¶12), Appx1817-2076, took over two years to complete. Appx0469(n.5). Inagaki discloses 30 possible refrigerants with *no* mention of *any* particular lubricant. Thus, there could not have been a reasonable expectation of success in finding a miscible combination. The Board’s failure to properly consider this evidence, and write it off as an “inherent” property, is legal error.

3. The Board Ignored Evidence of Long-Felt Need, Skepticism, Industry Praise, and Commercial Success Based on a Legally Erroneous Application of the “Nexus” Requirement.

As explained above, *Argument § II.A, supra*, much of the Board’s obviousness analysis treated Honeywell’s patent as if the discovery was simply the inherent properties of HFO-1234yf by itself rather than the combination of HFO-1234yf and PAG lubricant in combination. Incongruously, however, the Board explicitly disregarded much of Honeywell’s objective evidence for what was, in the Board’s view, an insufficient nexus to the combination of HFO-1234yf and PAG lubricant. *See* Appx0027 (“[W]e need only consider evidence related to the specific properties of the combination of HFO-1234yf and PAG, since it is arguably the only combination that is novel in the prior art.”). On that reasoning, the Board disregarded much of Honeywell’s evidence, stating that “[m]ost of Patent Owner’s evidence is introduced to show that a particular *refrigerant* having all of the desired properties sought after in the particular art ... was elusive to those in the art for a long time.” Appx0026-27 (original emphasis).

To ensure that objective evidence serves its intended purpose, “a nexus is required between the merits of the claimed invention and the [objective] evidence, if that evidence is to be given substantial weight.” *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 1539 (Fed. Cir. 1983). And the weight that objective evidence receives is “more or less,” depending on “the extent that the patentee demonstrates the required nexus.” *In re GPAC Inc.*, 57 F.3d 1573, 1580 (Fed. Cir. 1995). This Court, however, has “reject[ed] [the] categorical claim that objective evidence must be tied exclusively to claim elements that are not disclosed in a particular prior art reference in order for that evidence to carry substantial weight.” *WBIP*, 2016 WL 3902668, at *8. Rather, considerations such as commercial success “may be linked to an individual element or, ... to the inventive combination of known elements.” *Id.* It was thus error for the Board to disregard Honeywell’s objective evidence for being tied, in the Board’s view, to HFO-1234yf.

Had Honeywell’s evidence been considered properly here, it should have compelled reversal of the Examiner’s rejections. As discussed above, undisputed evidence demonstrates a long-felt need for a solution to the specific problem that Honeywell’s patent solved, and the failure

for decades of others—not for lack of trying—to solve that problem. *See Leo*, 726 F.3d at 1356 (“The elapsed time between the prior art and the ’013 patent’s filing date evinces that the ’013 patent’s claimed invention was not obvious to try.”); *Rosemount, Inc. v. Beckman Instruments, Inc.*, 727 F.2d 1540, 1546 (Fed. Cir. 1984) (similar); *Schenck v. Singer Mfg. Co.*, 77 F. 841, 844 (2d Cir. 1897).

Since at least 1987, and continuing until Honeywell’s invention in 2002, experts recognized the need to reduce global warming and ozone depletion caused by refrigerants. Appx0400; Appx0946-0949 (role as greenhouse gases a concern); Appx0385-0394 (disadvantage of HFC-134a is high GWP); Appx10734(2:12-15) (“[T]here is also a demand for the development of refrigerants that have a low ozone depletion potential while at the same time having a low GWP.”). Dr. Bivens explained that such long-felt need was driven not only by the environmental incentive of reducing harm to the atmosphere, but also by economic forces and regulations. Appx1785(¶5); Appx1787-1788(¶8). Despite having every incentive to pursue any promising alternatives to HFC-134a, Daikin abandoned its Inagaki patent application after 1992, and no one

discovered the utility of HFO-1234yf and PAG lubricants in combination until Honeywell did ten years later.

Likewise, the possibility of finding *any* solution to the problem of identifying acceptable refrigerants that also met environmental criteria was viewed with skepticism. In a 1997 article, two ASHRAE fellows remarked that “the probability of finding an ideal refrigerant, particularly with the exhaustive searches performed to date, is practically zero. Those waiting for a perfect solution will be disappointed.” Appx0970. In fact, conventional wisdom was that a decrease in ODP would lead to an increase in GWP, and vice versa. *See* Appx0965 (fig. 6).

When Honeywell’s invention became known, it was widely praised in the industry. One commenter remarked that “what was apparently impossible became possible.” Appx1022. Moreover, two of the inventors of the ’366 patent were awarded medals for their role in the development of HFO-1234yf, *see* Appx0380-0384(Exs. B and C), and the EPA praised Honeywell’s invention as a “homegrown innovative solution[].” Appx1016.

Honeywell’s invention has also been highly commercially successful. In addition to submitting numerous declarations detailing the first

three of these objective considerations, *see* Appx0364-0367(¶¶7-13), Appx1783-1788 (¶¶2-8), Appx0613 (¶4), Appx0615-0617(¶¶12-22), Honeywell submitted a declaration from Richard Winick, Honeywell's Global Director of Sales for the Fluorine Products business, describing the success of Honeywell's HFO-1234yf and its use with a PAG lubricant.

In his declaration, Mr. Winick explained that since 2002, "substantial commercial production facilities have either come on line or have been planned to come online for the production of HFO-1234yf. Essentially all of the output of these facilities is expected to be sold to customers purchasing it for use in applications to cool air in accordance with the requirements of the claims." Appx0610-0611(¶5). Mr. Winick stated that he expected Honeywell to "deliver to customers between 2012 and 2017... over 20 million pounds [of HFO-1234yf], and essentially all of this will be used in heat transfer compositions that include PAG lubricant." Appx0611(¶6). The Board's failure to consider Honeywell's commercial success evidence is particularly egregious because a nexus is presumed where, as here, objective evidence is "tied to a specific product and that product is the invention disclosed and claimed in the

patent.” *WBIP*, 2016 WL 3902668, at *6 (internal quotation marks omitted).

Finally, while some of Honeywell’s evidence focused on the properties of HFO-1234yf, not all of it did. Mr. Winick’s declaration, for example, specifically stated that Honeywell’s sales of HFO-1234yf were to customers who would use HFO-1234yf with a PAG lubricant, *i.e.*, the claimed invention. The Board’s failure to consider such evidence—on the ground that it was tied principally to HFO-1234yf rather than the claimed combination—was legal error.

III. The Board Improperly Applied Precedent Regarding the Obviousness of Optimal Ranges to Invalidate the Group VI and X Claims (36, 37, 46-49, 70, and 75).

The Board’s rejection of claims 36, 37, 46-49, 70, and 75 cannot stand for the additional reason that the Board’s analysis misapplies this Court’s precedent with respect to optimization of ranges. Claims 36, 37, 46-49 and 75 (the “Group VI” claims) require a specific GWP for the claimed composition. Claim 70 (the sole “Group X” claim) requires that the composition be “nonflammable.” All eight claims are reproduced on the inside-back cover of this brief. The Board found those claims obvious because it found the underlying independent claims obvious, and con-

cluded that GWP and flammability were merely parameters that a skilled artisan would have “optimized” in 2002. Appx0041-0042; Appx0048-0049; *see Statement of the Case § II.C.2, supra*.

The Board’s reasoning, however, depends on a critical missing premise. This Court’s precedent holds that optimization of a property of prior art is only obvious where the property is known in the prior art and recognized as a result-effective variable in the first place. *In re Antonie*, 559 F.2d 618, 620 (C.C.P.A. 1977); *see also In re Applied Materials, Inc.*, 692 F.3d 1289, 1297 (Fed. Cir. 2012) (There must be some “recognition in the prior art that a property is affected by the variable” in order to find that the variable is result-effective.). The Board never made any finding that the GWP or flammability of an HFO-1234yf mixture was result-effective because there was no finding that a skilled artisan knew the GWP or flammability of HFO-1234yf in 2002. Nor could the Board have made such a finding, as no such evidence was in the record. To hold, as the Board did, that a skilled artisan in 2002 would have “optimized” these unknown properties is classic hindsight and legal error. For that additional reason, the rejection of claims 36, 37, 46-49, 70, and 75 must be reversed.

CONCLUSION

For the foregoing reasons, the Board's decision should be reversed.

August 15, 2016

Respectfully submitted,

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ADDENDUM

Decision on Appeal (March 30, 2016)	Appx0001-0051
U.S. Patent No. 7,534,366	Appx0052-0059
37 C.F.R. § 41.77 (2012)	ADD-1-2

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MEXICHEM AMANCO HOLDING S.A. de C.V. and
DAIKIN INDUSTRIES, LTD.
Requesters and Respondents

v.

HONEYWELL INTERNATIONAL INC.
Patent Owner and Appellant

Appeal 2015-006430
Reexamination Control 95/002,189 and 95/002,204
Patent US 7,534,366 B2¹
Technology Center 3900

Before MARK NAGUMO, JEFFREY B. ROBERTSON, and
RAE LYNN P. GUEST, *Administrative Patent Judges*.

GUEST, *Administrative Patent Judge*.

DECISION ON APPEAL

¹ US Patent 7,534,366 B2 issued on October 9, 2007 to Rajiv R. Singh, et al.
(hereinafter “the ’366 patent”).

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Patent Owner Honeywell International Inc. (“Patent Owner”) appeals under 35 U.S.C. §§ 134(b) and 315(a) the Examiner’s decision to reject claims 1-26, 31-37, 46-49, 58, 59, 61-68, 70-75, 80 and 81. Patent Owner Appeal Brief 2, filed December 22, 2014 (hereinafter “PO App. Br.”). We have jurisdiction under 35 U.S.C. §§ 134(b) and 315(a).

This proceeding is the merged reexamination of Reexamination Control 95/002,189, filed September 12, 2012 by Third Party Requester Mexichem Amanco Holdings S.A. de C.V. (hereinafter “Requester Mexichem”) and Reexamination Control 95/002,204, also filed September 12, 2012 by Third Party Requester Daikin Industries, Ltd. (hereinafter “Requester Daikin”). Requester Mexichem and Requester Daikin are herein collectively referred to as “Requesters.” We heard oral arguments in this case on November 23, 2015, a written transcript of which was entered into the record on January 12, 2016.

Related U.S. Patent 8,033,120 (hereinafter “the ’120 patent”) is the subject of reexamination control 95/001,783 and related U.S. Patent 7,279,451 (hereinafter “the ’451 patent”) is the subject of reexamination control 95/000,576, which are also currently on appeal (Appeal 2015-000616 and Appeal 2015-000615, respectively). Requester Mexichem’s Respondent Brief 1, filed January 22, 2015 (hereinafter “Req. Mex. Br.”); Requester Daikin’s Respondent Brief 1, filed February 23, 2015 (hereinafter “Req. Dia. Br.”). Decisions on appeal for both cases are being issued concurrently herewith.

Requesters further identify related U.S. Patent 8,065,882 (hereinafter “the ’882 patent”) as the subject of reexamination control 95/002,030 and

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related U.S. Patent 8,053,404 (hereinafter “the ’404 patent”) as the subject of reexamination control 95/001,920, which are also currently on appeal.²

Related U.S. Patent 8,444,874 (hereinafter “the ’874 patent”) was subject to *Inter Partes* Review IPR2013-00576, in which a final decision was entered on February 26, 2015. The decision in IPR2013-00576 cancelled all of the claims of the ’874 patent except for claim 2, which recited a heat transfer composition comprising “at least about 90% by weight” of the trans-isomer of 1,3,3,3-tetrafluoropropene.

The ’451, ’366, ’120, and ’882 patents are also the subject of a litigation in the United States District Court for the Eastern District of Pennsylvania styled *Arkema, Inc. and Arkema France v. Honeywell International Inc.*, Civil Action No. 10-2886 (E.D. Pa.), which has been stayed pending the outcome of reexaminations of each of the involved patents.

We AFFIRM.

STATEMENT OF THE CASE

The ’366 patent relates to the use of heat transfer compositions comprising tetrafluoropropene (e.g., HFO-1234) in a variety of applications, including: vapor compression heating and cooling systems; blowing agents; aerosol propellants; solvent compositions; and fire suppressing agents. ’366

² Reexamination of the ’882 patent has been assigned Appeal 2015-007833, and oral hearing regarding this reexamination was heard on January 20, 2016. A decision on appeal for this case is being issued concurrently. No appeal number has yet been assigned to the appeal of the reexamination of the ’404 patent, which is still in the briefing stage.

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patent, col. 3, ll. 26 to col. 4, ll. 42. The claimed compositions are said to have low ozone depletion potential (“ODP”) and to have other advantages such as lower global warming potential (“GWP”). ’366 patent, col. 5, ll. 18-46. Claim 1, which is illustrative of the appealed subject matter, has not been amended during reexamination and reads as follows:

1. A heat transfer composition for use in an air conditioning system comprising:

(a) at least about 50% by weight of 1,1,1,2-tetrafluoropropene (HFO-1234yf)^[3] having no substantial acute toxicity; and

(b) at least one poly alkylene glycol [PAG] lubricant in the form of a homopolymer or copolymer consisting of 2 or more oxypropylene groups and having a viscosity of from about 10 to about 200 centistokes at about 37°C.

PO App. Br. 38, Claims App’x.

Patent Owner contests the Examiner’s decision to reject the claims as follows:

I. Claims 1, 2, 4–12, 15–17, 20–26, 31–37, 46–49, 58, 59, 61–68, 70–75, 80, and 81 stand rejected under 35 U.S.C. § 103(a) as

³ HFO-1234yf has the structure $F_3C-CF=CH_2$. Although claim 1 refers to HFO-1234yf as 1,1,1,2-tetrafluoropropene, the specification of the ’366 patent refers to HFO-1234yf as it is more often identified as 2,3,3,3-tetrafluoropropene. *See e.g.*, the ’366 patent, col. 4, ll. 47-48 and the ’120 patent, col. 4, ll. 54-55. However, the ’882 patent refers to HFO-1234yf as “1,1,1,2-tetrafluoropropene.” ’882 patent, col. 17, ll. 65-67, claim 7. The three names all refer to the same chemical compound.

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unpatentable over Inagaki⁴ in view of Magid.⁵ RAN 4 and 24 (Rejection I and XV).

II. Claims 3, 13, and 14 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Inagaki in view of Magid and Mahler.⁶ RAN 8 and 25 (Rejections II and XVIII).

III. Claims 4–7, 12, 17, 26, 32–37, 46–49, 58, 59, 61–64, 72, and 73 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Inagaki in view of Magid and Oberle.⁷ RAN 9 and 28 (Rejections III and XXIII).

IV. Claim 18 stands rejected under 35 U.S.C. § 103(a) as unpatentable over Inagaki in view of Magid and Thomas.⁸ RAN 10 and 29 (Rejections IV and XXVI).

V. Claims 1, 2, 4–12, 15–17, 19–26, 31–37, 46–49, 58, 59, 61–68, 70–75, 80, and 81 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Inagaki in view of ACURA⁹ and Patentee's Admissions.¹⁰ RAN 11 and 24 (Rejection V, XIII, and XIV).

⁴ JP H04-110388, published April 10, 1992 and naming Sadayasu Inagaki et al. as inventors.

⁵ U.S. Patent 4,755,316, issued July 5, 1988 to Hillel Magid et al.

⁶ U.S. Patent 6,991,744, issued January 31, 2006 to Walter Mahler et al.

⁷ U.S. Patent 6,374,629 B1, issued April 23, 2002 to Jill Ellen Oberle et al.

⁸ U.S. Patent 5,254,280, issued October 19, 1993 to Raymond H. P. Thomas et al.

⁹ Acura Service Bulletin No. 92-027, issued September 29, 1992, regarding 1993 Model NSX Legend.

¹⁰ As evidenced by remarks made in the original prosecution of U.S. Application 10/694,273 (now the '366 patent) in the Supplemental Response, filed November 10, 2008 at page 20, and the '366 Patent, col. 6, ll. 5-9. RAN 12.

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- VI. Claims 3, 13, and 14 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Inagaki in view of Acura/Patentee's Admissions and Mahler. RAN 15 and 25 (Rejections VI, XVI, and XVII).
- VII. Claims 4–7, 12, 17, 26, 32–37, 46–49, 58, 59, 61–64, 72, and 73 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Inagaki in view of Acura/Patentee's Admissions and Oberle. RAN 16 and 28 (Rejections VII, XXI, and XXII).
- VIII. Claim 18 stands rejected under 35 U.S.C. § 103(a) as unpatentable over Inagaki in view of Acura/Patentee's Admissions and Thomas. RAN 17, 28 and 29 (Rejections VIII, XXIV, and XXV).
- IX. Claims 1, 2, 4-12, 15-17, 19-26, 31-37, 46-49, 58, 59, 61-68, 70-75, 80, and 81 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Inagaki in view of Bivens.¹¹ RAN 18 (Rejection IX).
- X. Claim 3, 13, and 14 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Inagaki in view of Bivens and Mahler. RAN 20 (Rejection X).
- XI. Claims 4-7, 12, 17, 26, 32-37, 46-49, 58, 59, 61-64, 72, and 73 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Inagaki in view of Bivens and Oberle. RAN 21 (Rejection XI).

¹¹ U.S. Patent 6,783,691 B1, issued August 31, 2004 to Donald Bernard Bivens, et al.

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XII. Claim 18 stands rejected under 35 U.S.C. § 103(a) as unpatentable over Inagaki in view of Bivens and Thomas. RAN 23 (Rejection XII).

XIII. Claims 3, 13, and 14 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Inagaki in view of Acura/Patentee's Admissions or Magid and Minor.¹² RAN 25 and 27 (Rejections XIX and XX).

XIV. Claim 19 stands rejected under 35 U.S.C. § 103(a) as unpatentable over Inagaki in view of Acura/Patentee's Admissions or Magid and Katafuchi.¹³ RAN 29 and 31 (Rejections XXVII and XXVIII).

Requesters rely on the following evidence in support of the Examiner's maintained rejections:

Declaration of Stuart Corr executed May 1, 2013 (Ex. 2, Req. Mex. Br. 11; hereinafter "Corr Decl.") and attached exhibits.

Declaration of Takashi Shibnuma executed July 28, 2014 (Ex. 4, Req. Mex. Br. 11; Ex. 17, Req. Dai. Br., Exhibit App'x 2; hereinafter "Shibnuma Decl.") and attached exhibits.

JP H5-85970A, published April 6, 1993 and naming Yukio Omure et al. as inventors, and certified English language translation submitted therewith, dated April 30, 2013.¹⁴

¹² WO 02/46328 A2, published June 13, 2002 and naming Barbara Minor et al. as inventors.

¹³ U.S. Patent 6,013,609, issued January 11, 2000 to Tadashi Katafuchi.

¹⁴ Requesters identify the teachings of Omure in Requesters' Comments after the Patent Owner's Response to the Examiner's non-final office action, filed May 1, 2013, and in Requester's Comments filed after the Action Closing Prosecution, filed July 28, 2014. Accordingly, Patent Owner was

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Patent Owner relies on the following rebuttal evidence:

1. Declaration of Donald B. Bivens executed March 29, 2013 (Ex. A, App. Br. 45; hereinafter “First Bivens Decl.”) and attached exhibits.
2. Declaration of Richard D. Chambers executed March 27, 2013 (Ex. B, App. Br. 45; hereinafter “Chambers Decl.”) and attached exhibits.
3. Declaration of Michael B. Pate executed March 29, 2013 (Ex. C, App. Br. 46; hereinafter “Pate Decl.”) and attached exhibits.
4. Declaration of Joseph F. Posillico executed June 27, 2014 (Ex. D, App. Br. 47; hereinafter “Posillico Decl.”).
5. Declaration of Rajiv Ratna Singh executed March 30, 2013 (Ex. E, App. Br. 47; hereinafter “Singh Decl.”) and attached exhibits.
6. Declaration of Raymond H. Thomas executed March 29, 2013 (Ex. F, App. Br. 49; hereinafter “First Thomas Decl.”) and attached exhibits.
7. Declaration of Richard Winick executed March 29, 2013 (Ex. G, App. Br. 49; hereinafter “Winick Decl.”).
8. Second Declaration of Donald B. Bivens executed June 27, 2014 (Ex. H, App. Br. 49; hereinafter “Second Bivens Decl.”) and attached exhibits.
9. Second Declaration of Raymond H. Thomas executed June 27, 2014 (Ex. I, App. Br. 49; hereinafter “Second Thomas Decl.”) and attached exhibit.

on notice prior to briefing in this appeal as to Omure’s teachings as evidence of the state of the art at the time of the invention.

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OBVIOUSNESS REJECTIONS BASED ON INAGAKI

The Rejections

Sole independent claim 1 stands rejected over Inagaki in view of (a) Magid, (b) Acura and Patentee's Admissions, or (c) Bivens. Dependent claims stand rejected based on these references either with or without additional prior art.

The Examiner found, and Patent Owner does not dispute, that Inagaki teaches HFO-1234yf, the same refrigerant recited in claim 1. *See* RAN 5; PO App. Br. 15-16, Claim App'x; Inagaki 4–5 (Embodiment 5).

The Examiner further found that Inagaki describes that the disclosed refrigerants “do not have any problem with respect to their general characteristics (e.g., compatibility with lubricants, non-erodibility against materials, etc.).” RAN 7-8 and 40 (quoting Inagaki 3). Thus, the Examiner found that Inagaki “broadly teaches that the heat transfer compounds are compatible with lubricants” but does not teach the particular polyalkylene glycol (PAG) lubricant of claim 1. RAN 5.

The Examiner found that Magid teaches the use of polyoxypropylene glycols meeting the requirements of claim 1 for use with tetrafluoroethane in refrigeration equipment. RAN 6 (citing Magid, col. 3, ll. 34-54). The Examiner also found that Acura describes the use of a PAG lubricant, referred to as ND-8, which meets the requirements of claim 1, for use with R-134 in an automotive air conditioning system. RAN 12. The Examiner relied on Patent Owner's admission from page 20 of the Remarks made during the original prosecution in the Supplemental Response dated

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November 10, 2008, which states that ND-8 was “one of the most widely used lubricants by OEMs for automotive air conditioning systems.” *See* RAN 12 (quoting Requester Mexichem’s Request for *Inter Partes* Reexamination 28, filed September 12, 2012). Additionally, the Examiner found that Bivens teaches “that lubricants for HFC-based refrigeration systems are polyalkylene glycols and polyol esters.” RAN 18.

Accordingly, the Examiner determined that a heat transfer composition comprising HFO-1234yf and PAG (namely ND-8) in an air conditioning system would have been obvious to one having ordinary skill in the art at the time the invention with a reasonable expectation of success because the refrigerant is compatible with lubricants in view of the prior art of record. RAN 6, 12, and 18-19.

Discussion

Claims 1, 3, 5, 6, 8, 11-16, 18-20, 23-25 and 31-33

Issue

Although some claims stand rejected separately, Patent Owner argues claims 1, 3, 5, 6, 8, 11-16, 18-20, 23-25 and 31-33 as a group based on the Examiner’s similar reliance on the teachings of Inagaki in view of Magid, Acura/Patentee’s Admissions, or Bivens. PO App. Br. 13. Accordingly, we address claim 1 as representative of the rejection of the claims, with the understanding that our comments apply equally to the rejections of dependent claims 3, 5, 6, 8, 11-16, 18-20, 23-25 and 31-33.

Patent Owner contends that the Examiner has not established a *prima facie* case of obviousness because Inagaki fails to disclose an embodiment of

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a heat transfer composition comprising HFO-1234yf and polyalkylene glycol (PAG), and that such a combination would not have been obvious to the skilled artisan. PO App. Br. 16 and 24-30. Patent Owner argues that Inagaki is silent as to combining the described hydrofluoroolefins, including HFO-1234yf, with any particular lubricant. *Id.* at 16. In particular, Patent Owner contends that, although Inagaki describes “compatibility” with lubricants, Inagaki does not explain what it means by “compatibility,” and does not discuss any reason to expect that the combination of HFO-1234yf and PAG would have been miscible or stable with any particular lubricant, particularly with PAG. PO App. Br. 16-17. Patent Owner further argues that Inagaki does not suggest combining with PAG because it specifically states combining HFOs with known HCFCs and CFCs to “improve solubility” and demonstrates an operational embodiment that includes an oil separator, and thus an expectation that the hydrofluoroolefins would have been combined with immiscible lubricants. *Id.* (citing Bivens Decl. ¶ 22 and Thomas Decl. ¶¶ 4-7).

Patent Owner also argues that Inagaki does not disclose or render obvious the “no substantial acute toxicity” limitation of claim 1 because Inagaki teaches additional compounds found to have a high level of acute toxicity, and thus does not describe HFO-1234yf as “having any advantage over any other compounds.” PO App. Br. 16 and 21-22. Specifically, Patent Owner contends that Inagaki discloses HFO-1225zc and HFO-1243zf as having unacceptable toxicity and flammability for most air conditioning applications. *Id.* (citing Singh Decl. ¶¶ 5-9 and 28).

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Patent Owner further contends that Magid, Acura, and Bivens are directed only to saturated hydrofluorocarbons (“HFC”), and that there is no basis to conclude that the results would have been predictable with HFO-1234yf, as described in Inagaki, which is an unsaturated compound. *Id.* at 17-21 and 23-24. Rather, Patent Owner argues that these references show the unpredictability of combining refrigerants and lubricants, even between similar compounds such as R-134a and R-12. *Id.* (citing Bivens Decl. ¶¶ 7, 26-29; Thomas Decl. ¶ 27; Pate Decl. ¶ 12). Patent Owner contends that the statements relied upon by the Examiner as an admission are only directed towards confirmation that ND-8 was a known PAG lubricant at the time of the invention. PO App. Br. 21. Patent Owner argues that Bivens and other patents confirm problems with using PAG as a lubricant and a preference for mineral oils and alkylbenzenes due to problems with moisture and the formation of sludges. *Id.* at 21 and 25.

Patent Owner argues that, because some of the compounds taught by Inagaki would have been understood to be reactive or unstable, as hydrofluoroolefins in general were understood to be at the time of the invention, one of ordinary skill in the art would not have been led by Inagaki to combine HFO-1234yf with PAG, which was also understood to be an unstable compound. *Id.* at 10-11 and 25-27. In particular, Patent Owner contends that peroxide formation would have been expected to lead to degradation reactions of HFO compounds that are not possible with HFC compounds. *Id.* at 25 (citing Thomas Decl. ¶ 5; Chambers Decl. ¶¶ 5-14).

Patent Owner contends that Inagaki fails to disclose an embodiment of a heat transfer composition comprising a refrigerant and a lubricant,

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particularly a composition with the desired miscibility of the claims. PO App. Br. 14-17; *see also* PO App. Br. 27-28.

Patent Owner contends that HFO-1234yf exhibits unexpected stability in combination with PAG over other similar refrigerants in combination with PAG. PO App. Br. 25-27. Further, Patent Owner argues that the present invention addresses the long-felt-but-unmet need for a heat transfer composition having necessary environmental properties, such as low ozone depleting potential (ODP) and low global warming potential (GWP). *Id.* at 6-12. In particular, Patent Owner presents evidence of skepticism that such a composition existed, particularly with the other desired properties of low toxicity, stability, reactivity, and effectiveness. *Id.*

The issue with respect to these claims is:

Did the Examiner err in determining that one of ordinary skill in the art would have formulated a heat transfer composition comprising HFO-1234yf and PAG from the teachings of Inagaki, Magid, Bivens, or Acura and Patentee's Admissions, and in light of the evidence of secondary consideration, namely unexpected results, long-felt-but-unmet need, and skepticism?

Analysis

Although Inagaki discloses that the refrigerants disclosed therein are compatible with lubricants (Inagaki 3), we agree with the Patent Owner that Inagaki does not teach any particular lubricant and refrigerant pairs, such that Inagaki does not expressly teach a heat transfer composition with HFO-1234yf and PAG, as recited in claim 1. However, the Examiner's rejection is not an anticipation rejection, but an obviousness rejection under 35 U.S.C.

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§ 103(a) that includes references that expressly teach that PAG was a well-known class of lubricant and ND-8, a PAG, was the most commonly used lubricant at the time of the invention.

Inagaki teaches a generic refrigerant having the formula $C_3H_mF_n$, wherein m and n are integers from 1–5 and the sum of m and n is equal to 6, which has no destructive effects on the ozone layer, because it contains no chlorine or bromine atoms. Inagaki 2. More critically, Inagaki exemplifies the refrigerant $F_3C-CF=CH_2$, also known in the art as HFO-1234yf or (2,3,3,3-tetrafluoropropene), which is the refrigerant recited in the claims. *Id.* at 4 (Embodiment 5). Inagaki teaches that the coefficient of performance (COP) and freezing effect results for HFO-1234yf were similar to those obtained for embodiment 1 (*id.*), for which Inagaki shows “excellent” COP values and “higher” freezing capacity than the control refrigerant (R-12). *Id.* at 3. Accordingly, Inagaki evinces that at the time of the invention HFO-1234yf would have been known to those of skill in the art to be a refrigerant with good COP and good freezing effect with no destructive effects on the ozone layer. We find it of no moment that Inagaki also discloses other refrigerants. *See Merck & Co. v. Biocraft Labs.*, 874 F.2d 804, 807 (Fed. Cir. 1989) (“That the [prior art] discloses a multitude of effective combinations does not render any particular formulation less obvious. This is especially true because the claimed composition is used for the identical purpose.”).

In addition to good cooling characteristics, Inagaki describes that HFO-1234yf is an ozone-friendly compound. Thus, despite the fact that HFO-1234yf possesses attributes (e.g., non-toxicity, stability, etc.) that were

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yet to be recognized in the art, Inagaki teaches using HFO-1234yf, for example, as a known refrigerant at the time of the invention.¹⁵ Here, the Examiner's reasoning that a skilled artisan would have used HFO-1234yf due to the good COP and capacity and ozone friendly properties described in Inagaki is supported by the preponderance of the teachings of the prior art.

Moreover, the properties of the particular refrigerants are inherent to the *refrigerant*, whether specifically disclosed or not. Such inherent properties of refrigerants include their specific toxicity, miscibility, GWP, and ODP, whether or not these properties are predictable. One cannot obtain a patent for a composition of matter based on the inherent properties of an otherwise known refrigerant. "Inherency is not necessarily coterminous with the knowledge of those of ordinary skill in the art. Artisans of ordinary skill may not recognize the inherent characteristics or functioning of the prior art." *In re Cruciferous Sprout Litig.*, 301 F.3d 1343, 1349 (Fed. Cir. 2002). The new realization alone does not render that prior art patentable. "From the standpoint of patent law, a compound and all of its properties are inseparable; they are one and the same thing." *In re Papesch*, 315 F.2d 381, 391 (CCPA 1963). "[T]he discovery of a previously unappreciated property of a prior art composition, or of a scientific

¹⁵ Moreover, evidence of record suggests that the particular concerns with stability, toxicity, and reactivity were known in the art at the time of the invention and the testing of prospective refrigerants for these properties was routine in the art at the time of the invention. *See* Second Singh Decl. ¶¶ 6–7 (citing a Declaration of George Rusch (attached as Exhibit B to the Second Singh Decl.), which discusses testing of HFO-1225zc performed by Dupont that is dated April 17, 2000); Bivens Decl. ¶ 9, n. 4 (citing Exhibit G, a 1992 NASA JPL tech brief identifying potential refrigerant candidates as toxic).

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explanation for the prior art's functioning, does not render the old composition patentably new to the discoverer.” *Atlas Powder Co. v. Ireco, Inc.*, 190 F.3d 1342, 1347 (Fed. Cir. 1999). *See also In re Skoner*, 517 F.2d 947, 950 (CCPA 1975) (“Appellants have chosen to describe their invention in terms of certain physical characteristics Merely choosing to describe their invention in this manner does not render patentable their method.”).

We are not persuaded that any expected difficulties or problems associated with the use of HFO-1234yf, such as toxicity, would have deterred an ordinary artisan from using HFO-1234yf as a refrigerant in known refrigerant applications, as evidenced by Inagaki. *Cf.* PO App. Br. 21-24 (describing expected, although not realized, concerns regarding toxicity and reactivity). Even if expected to be toxic, flammable, reactive, etc., the skilled artisan would have recognized the tradeoff of these properties for the benefits of good cooling with little effect on the ozone layer and would have used Inagaki's refrigerants in air conditioning equipment accordingly, as taught by Inagaki. *See* Singh Decl. ¶ 14 (citing Exhibit K, which is a 1997 article entitled “Trade-Offs in Refrigerant Selections.”); Singh Decl. ¶ 13, Exhibit G and First Bivens Decl. ¶ 9, n. 4, Exhibit F (a 1987 article entitled “*Quest for Alternatives: A Molecular Approach Demonstrates Tradeoffs and Limitations Are Inevitable in Seeking Refrigerants*”).

It is enough that the prior art reference describes excellent COP, freezing effect, and low ODP to provide sufficient reasons for the skilled artisan to use HFO-1234yf as a refrigerant as required by claim 1. HFO-1234yf is non-toxic, non-flammable, miscible and stable in lubricants,

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and has low GWP whether it is used for exploiting these properties or for the cooling and ozone-friendly properties described in Inagaki. “[A]ny need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.” *KSR Int’l v. Teleflex, Inc.*, 550 US 398, 420 (2007).

We agree with Patent Owner that Inagaki does not describe any particular cooling machine oil. However, using cooling machine oils known to those of ordinary skill in the art at the time of the invention would have been obvious based on the teachings of Inagaki. Again, the preponderance of the evidence of record indicates that PAG and polyol ester (POE) were known in the art as conventional lubricants in refrigerant systems, i.e., “cooling machine oils,” at the time of the invention. *See* Singh Decl. ¶ 7 (“One of the most widely used PAG lubricants at the time the present invention was made, and continuing through to the present time, is the PAG lubricant manufacture by Idemitsu Kosan and sold under the trade designation ND-8.”); Bivens, col. 1, ll. 37–50 (identifying PAG and POE as known alternative lubricants for HFC-based refrigeration systems). Even the ’366 patent describes that certain lubricants were well known in the art at the time of the invention. ’366 patent, col. 2, ll. 22-25 (“the types of *lubricants used traditionally with CFC’s and HFC’s*, including, for example, mineral oils, alkylbenzenes or poly (alpha-olefins).”) (emphasis added); col. 6, ll. 5-9 (“*Commonly used refrigeration lubricants* such as Polyol Esters (POEs) and Poly Alkylene Glycols (PAGs), silicone oil, mineral oil, alkyl benzenes (ABs) and poly (alpha-olefin) (PAO) that are used in refrigeration machinery with hydrofluorocarbon (HFC) refrigerants may be used with the

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refrigerant compositions of the present invention.”) (emphasis added). Since Inagaki evinces that it would have been obvious to one of ordinary skill in the art at the time of the invention to have used HFO-1234yf in combination with known lubricants, Inagaki would have also suggested the use of HFO-1234yf with, for example, PAG in a refrigerant composition.

Moreover, the combination of HFO-1234yf and PAG specifically would have been suggested by the teachings of Inagaki in view of Magid, Acura and Patent Owner’s admissions, and Bivens, which particularly recite PAG as a known lubricant in systems that use refrigerants and ND-8 as the most commonly used lubricant. Known drawbacks associated with the use of PAG as a lubricant discussed in the prior art do not outweigh this suggestion, since there is no dispute that the prior art specifically teaches that PAG and POE have been used and are known “suitable lubricants for HFC-based refrigeration systems,” even despite these known drawbacks. Bivens, col. 1, ll. 17–18. Thus, the skilled artisan would have recognized PAG as a conventional lubricant in refrigerant cooling systems. “A known or obvious composition does not become patentable simply because it has been described as somewhat inferior to some other product for the same use.” *In re Gurley*, 27 F.3d 551, 553-4 (Fed. Cir. 1994).

Although the secondary references disclosing lubricants are directed to saturated hydrofluorocarbons, the secondary references are only relied upon for demonstrating that PAG, particularly ND-8, was a known lubricant for use with refrigerant systems as described in Inagaki. Inagaki itself would have suggested combining unsaturated HFO-based refrigerants with the lubricants disclosed in the secondary references, because Inagaki teaches

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that HFO-1234yf has good COP and freezing effect, is ozone friendly, and is compatible with lubricants. Any of these properties would have led the skilled artisan to use HFO-1234yf with known lubricants. Thus, it is of no moment that the secondary references do not describe the use of PAG with unsaturated HFO-based refrigerants, because the combination of lubricants and unsaturated HFO-based refrigerants is described in Inagaki. One cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. *See In re Keller*, 642 F.2d 413 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091 (Fed. Cir. 1986).

Dr. Bivens testifies that miscibility and stability with respect to saturated HFC compounds would have been unpredictable with respect to unsaturated HFO compounds, as taught by Inagaki, because a double bond “significantly impacts the chemical and physical properties of the refrigerant such as, for example, toxicity, thermal and chemical stability, flammability, miscibility with lubricants, and compatibility of refrigerant/lubricant mixtures with system materials of construction.” First Bivens Decl. ¶ 7. As discussed above, Inagaki provides evidence that HFO-1234yf is a good and ozone friendly refrigerant and can be used with a lubricant. The properties discussed by Dr. Bivens, including miscibility and stability of HFO-1234yf with PAG, are inherent characteristics of HFO-1234yf, and the record provides sufficient evidence that the skilled artisan would have used HFO-1234yf with known lubricants, such as PAG.

“[O]bviousness cannot be avoided simply by a showing of some degree of unpredictability in the art so long as there was a reasonable probability of success.” *Pfizer, Inc. v. Apotex, Inc.*, 480 F.3d 1348, 1364

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(Fed. Cir. 2007). Thus, if the properties of refrigerants were all recognized as being unpredictable, and yet routinely tested in order to determine whether a particular compound would be suitable for a given application, identification of these properties for known refrigerants would have been obvious unless the needed testing was outside of the skill of the ordinary artisan. Patent Owner has not shown that testing for miscibility and stability of a refrigerant/lubricant pair was anything other than routine in the art.

Moreover, Patent Owner's argument that miscibility is unpredictable is not persuasive of non-obviousness. Magid, Acura, Bivens, and statements in the '366 patent support a finding that, generally, PAG and POE were used as replacement lubricants with certain saturated HFC compounds that were known to be immiscible with mineral oil or alkylbenzene. *See* Bivens, col. 1, ll. 36-42; '366 patent, col. 2, ll. 20-25 and col. 6, ll. 5-9; Magid, col. 4, l. 26 to col. 5, l. 41; Acura 1, col. 1, last two ¶¶; *see also* Mahler, col. 1, ll. 39-45; Thomas Decl. ¶ 8 (describing three classes of lubricants – mineral oil, polyol ester oil (POE), and polyalkylene glycol (PAG)). Thus, despite the unpredictable nature of miscibility and stability, the art recognized that, for refrigerant compounds that were not miscible in mineral oil, alternative miscible lubricants were available in the art, namely PAG and POE. Thus, the skilled artisan would have had a reasonable expectation that Inagaki's HFO-1234yf was miscible either with mineral oils and alkylbenzenes or alternatively with PAG and POE, particularly in light of Inagaki's teaching of compatibility with lubricants. *In re O'Farrell*, 853 F.2d 894, 903-04 (Fed. Cir. 1988) ("For obviousness under §103, all that is required is a reasonable expectation of success.") (citations omitted).

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We are not persuaded by Patent Owner's contentions regarding the depiction in Figure 2 of Inagaki of an oil separator, which is not otherwise discussed in Inagaki. App. Br. 16. Inagaki expressly teaches that compatibility and solubility with machine oils is a desirable property. Thus, the incidental disclosure of an oil separator in a general purpose testing apparatus does not teach away from miscible combinations of refrigerants and lubricants.

Further, we note that Patent Owner's argument that the skilled artisan would not have understood that "compatibility" includes "miscibility" (PO App. Br. 16) is inconsistent with the language used in the '366 patent, which interchanges the terms "compatibility" and "miscibility" throughout. *See* e.g., '366 patent, col. 2, ll. 16–35; *see also* Corr Decl. ¶¶ 40–41 ("compatible" generally means having a "satisfactory degree of chemical stability and sufficient miscibility/solubility and lubricity to enable it to be used under conditions appropriate to the envisaged application"). *Cf.* Bivens Decl. ¶¶ 23–24; Pate Decl. ¶ 19.

Secondary Considerations

Patent Owner contends that the Examiner has not properly considered Appellants' evidence of non-obviousness. PO App. Br. 12. Specifically, Patent Owner contends that there is evidence of unexpected results and industry praise. PO App. Br. 11–12. Patent Owner also argues that there was a long-felt need in the art for a refrigerant that possessed "not only these properties (low ODP and low GWP), but also must possess the properties of many of the widely-used compositions, such as excellent heat transfer,

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chemical stability, low toxicity, non-flammability, and acceptable refrigerant/lubricant miscibility, among other properties” and skepticism that the combination of all such properties could be met. *Id.* at 3 and 12.

After careful review of the evidence as a whole, we determine that Patent Owner’s evidence is unpersuasive as to the legal conclusion that the use of HFO-1234yf as a refrigerant in combination with PAG as a lubricant would not have been obvious to one of ordinary skill in the art.

In order for evidence of secondary considerations to be persuasive, the Patent Owner has the burden to show a “nexus” or link between what is claimed and the evidence of secondary considerations. *See In re GPAC Inc.*, 57 F.3d 1573, 1580 (Fed. Cir. 1995). Secondary considerations are generally not persuasive when the prior art possesses the same characteristics relied upon by the patent owner in the evidence of the secondary consideration. *In re Baxter Travenol Labs.*, 952 F.2d 388, 392 (Fed. Cir. 1991); *J.T. Eaton & Co., Inc. v. Atlantic Paste & Glue Co.*, 106 F.3d 1563, 1571 (Fed. Cir. 1997). For a secondary consideration to be persuasive evidence of nonobviousness, it must be connected directly to claimed features of the claimed invention, and provide properties beyond what would have been expected based on the prior art. *Baxter*, 952 F.2d at 392 (“[W]hen unexpected results are used as evidence of nonobviousness, the results must be shown to be unexpected compared with the closest prior art.”).

Most of Patent Owner’s evidence is introduced to show that a particular *refrigerant* having all of the desirable properties sought after in the particular art, namely environmentally friendly, non-toxic, miscible and

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stable with lubricants, and good cooling characteristics (i.e., good COP) was elusive to those in the art for a long time. Yet, such a refrigerant existed and was known as a good refrigerant at the time, as described in Inagaki. Accordingly, a solution to the need for a refrigerant was taught or suggested in the art well before the Patent Owner's identification of the additional beneficial properties of HFO-1234yf and HFO-1234ze. *Asyst Techs., Inc. v. Emtrak, Inc.*, 544 F.3d 1310, 1316 (Fed. Cir. 2008) (“[T]here was no evidence that the success of the commercial embodiment . . . was attributable to the . . . *only material difference between [the prior art] and the patented invention.*”) (citation omitted, emphasis added); *In re Kao*, 639 F.3d 1057, 1068 (Fed. Cir. 2011) (“Where the offered secondary consideration actually results from something other than what is both claimed and *novel* in the claim, there is no nexus to the merits of the claimed invention”). Here, the difference between the closest prior art and the claims is not the selection of HFO-1234yf as a refrigerant, because the use of this compound as a refrigerant is taught expressly by Inagaki for common refrigerant purposes.

Rather, we need only consider evidence related to the specific properties of the combination of HFO-1234yf and PAG, since it is arguably the only combination that is novel in the prior art. Patent Owner argues that the particular combination of HFO-1234yf and PAG exhibits “surprising stability even under extreme conditions.” PO App. Br. 26; PO Reb. Br. 5–7. Patent Owner includes stability data that demonstrates that “no tested fluorinated propene except HFO-1234yf exhibited acceptable stability with all three [stability] tests.” PO App. Br. 26-27.

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Dr. Thomas testified to conducting three different stability tests, in which the stability is characterized by: the “Fluoride value,” which represents the amount of free fluorine ions available, the “Total Acid Number (TAN),” and whether or not dimerization of the fluorinated olefin in the presence of the lubricant occurs for PAG in combination with five HFO compounds, including HFO-1234yf. First Thomas Decl. ¶ 23–26. The results of the stability test are found in Table 3 of Exhibit G, of Dr. Thomas’s First Declaration, which is reproduced below.

TABLE 3

	Fluoride	TAN	Dimers
1243zf	2.8	1.6	Yes
1234yf	75	2.55	No
1234ze	2166	5	No
1225yez	216	2.2	No
1261yf	160,000	85	Not possible to measure

Table 3 shows that 1234yf has relatively low “Fluoride value,” relatively low TAN, and no dimerization. According to Dr. Thomas, the results demonstrate “dramatically and unexpectedly superior” stability of the combination as compared to “the structurally similar compound HFO-1234ze.” *Id.*

Dr. Chambers explains that there are “reactive tendencies” between PAG and HFO-1234yf that were “possible and potential problems” anticipated by the skilled artisan upon combining HFO-1234yf and PAG.

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Chambers Decl. ¶ 14 and ¶¶ 11-13. The reactions identified by Dr. Chambers all involve hydroxyl groups or peroxides that may or may not be present in PAG (*see* Chambers Decl. ¶¶ 8, 9 and 10) and the reactive nature of fluoroalkenes because of the presence of a double bond and reactive fluorine atoms. *See* Chambers Decl. ¶¶ 11-13. Dr. Chambers testifies that “it would have been quite surprising and unexpected to a person of ordinary skill in the art at the time of Honeywell’s invention to find that the combination of HFO-1234yf and PAG (as discussed in the declaration of Mr. Thomas) exhibits such an improved level of stability compared to the combination of PAG lubricants with other fluorinated propenes.” *Id.*, ¶ 5, 14, and 15 (“it would have been surprising and unexpected to a person of ordinary skill in the art to find that this combination of HFO-1234yf and PAG is more stable than the combination of PAG lubricants with other fluorinated propenes (see Thomas declaration).”).

The Examiner determined that the stability data “do not contradict the fact that the stability is an inherent property of the refrigerant/lubricant pair.” RAN 34. We disagree. Even inherent properties, to the extent that they demonstrate results beyond what would have been expected to one of ordinary skill in the art, particularly superior results that demonstrate more than a mere improvement in a property, are evidence that the invention is non-obvious and must be considered accordingly. *In re Geisler*, 116 F.3d 1465, 1470 (Fed. Cir. 1997).

Requester Mexichem contends that neither the stability of HFO-1234yf alone nor the stability of PAG alone is improved by the combination. Req. Mex. Br. 3, 5 and 6. Mexichem’s argument is not persuasive because

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Patent Owner is not suggesting an unexpected improvement over the stability of HFO-1234yf and PAG independently. Rather, Patent Owner is arguing that the particular combination of HFO-1234yf and PAG demonstrate superior stability over other combinations of HFO compounds in PAG.

Both Requesters contend that a person skilled in the art would have expected that the claimed combination of HFO-1234yf and PAG would have excellent stability based on the teachings of Omure, which states that a different unsaturated propene HFO compound, 2-trifluoromethyl-3,3,3-trifluoropropene (hexafluoroisobutylene or HFIB),¹⁶ has “relatively superior thermal stability” when used as a refrigerant. Omure, ¶ 14; *see* Req. Mex. Br. 6, Req. Dia. Br. 13. We agree with the Patent Owner that similar stability of HFO-1234yf in PAG would not have been expected (*see* PO Reb. Br. 6) because the evidence taken as a whole shows individual refrigerants are not predictable as to their properties under the same or similar conditions, and thus, the benefits of one hydrofluoropropene would not have been predictive of the stability of other hydrofluoropropenes. *See e.g.* Patent Owner’s Rebuttal Brief 6, filed April 23, 2015; Chambers Decl. ¶¶ 5-14;

¹⁶ HFIB is a isobutylene compound having the structure $\text{CH}_2=\text{C}(\text{CF}_3)_2$. Omure’s refrigerant compound is a hydrofluoroolefin, in that it comprises hydrogen, carbon and fluorine atoms and an unsaturated double bond. HFIB falls within the scope of general formula I of the ’366 patent (col. 3, ll. 39-44), which is not limited to X being a primary alkyl radicals. HFIB does not fall within the scope of formula II of the ’366 patent (col. 4, ll. 1-12), which is limited to straight chain propenes and butenes. HFIB also does not fall within the general formula described in Inagaki, because it has 4 carbon atoms, and Inagaki is limited to compounds with 3 carbon atoms. Inagaki 1, first full ¶.

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Thomas Decl. ¶ 21; 2nd Thomas Decl. ¶ 4 (which describes known stability problems with PAG and saturated HFC, which is contrary to Dr. Chamber's testimony in ¶ 10 that stability problems would not have been expected with saturated HFCs).

Patent Owner has the burden of showing by at least a preponderance of the evidence that the results presented would have been unexpected to render combined teachings non-obvious. However, Omure's statement that another HFO compound, also having a double bond and highly reactive fluorine atoms, shows superior thermal stability is a fact that we weigh against Dr. Chamber's assertion that the results of HFO-1234yf in PAG were necessarily unexpected. Rather, the evidence presented by Patent Owner as a whole shows the unpredictability of how various refrigerants would have reacted with various lubricants. Thus, as evidenced by Omure, the skilled artisan would no more have expected failure with respect to the stability of combining hydrofluoroolefins with PAG than would have expected success. Additionally, Dr. Thomas' testimony suggests that the stability tests performed by him were routine in the art, and common, or even required, when considering any particular refrigerant/lubricant combination. *See* Thomas Decl. ¶ 23 ("The procedure described herein and the test results reported below are known and accepted as being indicative of the stability of such compositions for use in refrigeration systems.") and ¶¶ 24-25 and Exhibits E and F (describing that tests were performed by American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRE) or American Society for Testing Materials (ASTM) standards).

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Moreover, we agree with the Examiner that not all the stability data shown in Table 3 of the Thomas Declaration shows that the claimed combination is more stable when compared to the combination of other fluorinated propenes with PAG lubricants. RAN 35; Thomas Decl. ¶¶23-26, Ex. G. Rather, Table 3 shows HFO-1243zf having a lower “Fluoride value” and lower “TAN” value over that of HFO-1234yf. Patent Owner argues that we should credit the lack of dimerization shown in HFO-1234yf as constituting a more stable combination than a combination that has much lower Fluoride value and TAN value. PO app. Br. 26 (citing Thomas Decl. ¶ 26). Patent Owner cites Dr. Thomas’ explanation that dimerization is also indicative of “its potential to create components that may have a deleterious effect on the operation of many air conditioning systems.” *Id.* (citing Thomas Decl. ¶ 26). While this may be an additional disadvantage of dimerization, Dr. Thomas’ statement does not suggest that dimerization is a more critical factor when measuring stability than the other stability factors measured by Dr. Thomas. Moreover, HFO-1225yez also has no dimerization and has a lower TAN value than that of HFO-1234yf, suggesting that lack of dimerization is not a critical factor. Patent Owner has not explained why we should credit the improvement in Fluoride value shown in HFO-1234yf over a lower TAN value and equivalent dimerization of HFO-1225yez.

Merely an increase in some stability metrics for the combination of HFO-1234yf and PAG alone over some refrigerant/PAG pairs, when weighed in light of the evidence of routine testing and overall unpredictability as to stability in the art, is not persuasive as evidence of

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unexpected results. *See In re Chupp*, 816 F.2d 643, 646 (Fed. Cir. 1987) (“[T]he mere submission of some evidence that a new compound possesses some unpredictable properties does not require an automatic conclusion of nonobviousness in every case.”); *In re Merck*, 800 F.2d at 1099 (“In the absence of evidence to show that the properties of the compounds differed in such an appreciable degree that the difference was really unexpected, we do not think that the Board erred in its determination.”); *In re Merz*, 97 F.2d 599, 601 (C.C.P.A. 1938) (applicant “is not entitled to a patent on [an] article which after being produced has a greater degree of purity than the product produced by former methods” unless the “properties and characteristics which were different in kind from those of the known product rather than in degree”); *In re Woodruff*, 919 F.2d 1575, 1578 (Fed. Cir. 1990).

Further, even if the data of Table 3 shows an improvement in stability of HFO-1234yf in PAG over the other tested HFO compounds in PAG because good (if not the best) results were achieved in all (rather than just some) metrics, such is not by itself sufficient to demonstrate unexpected results. That is, the data are insufficient to support the testimony of Dr. Thomas and Dr. Chambers that this improvement would have been unexpected and that the results of combining HFO-1234yf in PAG would not have been obvious. The data is particularly unpersuasive when weighed in light of the overall unpredictability in the art and other HFO compounds in the art having “superior thermal stability” in PAG, as evidenced by Omure.

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Accordingly, we do not find that Patent Owner's evidence of secondary consideration persuasively supports a determination of non-obviousness over the combination of Inagaki and Magid, Acura and Patentee's admission, or Bivens.

Claims 2, 9, 10, 58, and 59

Issue

Patent Owner presents separate arguments for claims 2, 9, 10, 58, and 59. *See* PO App. Br. 30. These claims recite variously that the composition has a maximum GWP of 150, 100, or 75. Claims 2, 9, 10, 58, and 59 stand rejected under 35 U.S.C. § 103(a) as being obvious over Inagaki in view of Magid, Acura and Patentee's admission, or Bivens. We select claim 2 (reciting a maximum GWP of 75) as a representative claim.

In addition to the arguments discussed above for claim 1, Patent Owner contends that Inagaki does not support a conclusion that a composition using a refrigerant with a GWP of less than 75 would have been obvious because: (1) there is no express disclosure of this requirement; (2) not all heat transfer media within Inagaki necessarily produce a GWP as low as required by the claims and thus a finding of inherency is in error; and (3) Inagaki teaches improving solubility by adding saturated HFCs or HCFCs that are known to have a high GWP. PO App. Br. 30-31 (citing Singh Decl. ¶¶ 12-13 and Bivens Decl. ¶¶ 7-9).

The issue with respect to claims 2, 9, 10, 58, and 59 is:

Did the Examiner err in determining that one of ordinary skill in the art would have formulated a heat transfer composition having a refrigerant

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with the low GWP property recited in the claims from the teachings of Inagaki?

Analysis

Because Inagaki expressly teaches the use of HFO-1234yf as a refrigerant, the use thereof, and of all the properties associated with the refrigerant, would have been obvious, including the refrigerant's low GWP.¹⁷ *See Atlas Powder*, 190 F.3d at 1347; *see also* Corr Decl. ¶ 65.

Although it would have been obvious to the skilled artisan to have combined the low GWP HFO-1234yf refrigerant with other known refrigerants that have substantially higher GWP, Inagaki specifically teaches the use of HFO-1234yf alone in Embodiments 5. Thus, Inagaki teaches embodiments of processes using refrigerants that inherently have a GWP within the recited range, because those embodiments have no additional refrigerants other than HFO-1234yf.¹⁸ One cannot obtain patentability based on these inherent properties of an otherwise known refrigerant. The new realization alone does not render that prior art patentable. Additionally, for the reasons discussed above, we find Patent Owner's evidence of secondary considerations to be unpersuasive of non-obviousness over the prior art.

¹⁷ There is evidence of record that HFO-1234yf has a GWP of 4. *See* Singh Decl. ¶ 19 and Exhibit P; Req. Mex. Br. 6-7. *See also* RAN 55 (Examiner reasoned that identical fluoroalkene compounds would have the same low GWP as claimed).

¹⁸ It is our understanding that heat transfer composition components other than refrigerants need not be considered as significant contributors to GWP. For example, the evidence describes only the regulation of refrigerant components of known heat transfer compositions. *See e.g.*, Singh Decl. ¶ 13 and Exhibits E-J. That is, conventional lubricants and non-refrigerant additives appear to make negligible contributions to GWP.

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Accordingly, we affirm the Examiner's rejection of claims 2, 9, 10, 58, and 59 under 35 U.S.C. § 103(a) as obvious over Inagaki in view of Magid, Acura and Patentee's admission, or Bivens.

Claim 21

Issue

Patent Owner presents separate arguments for claim 21. *See* PO App. Br. 30. Claim 21 depends from claim 1 and further recites that the composition "has one liquid phase at at least one temperature between about -50°C and +70°C." Claim 21 stands rejected under 35 U.S.C. § 103(a) as being obvious over Inagaki in view of Magid, Acura and Patentee's admission, or Bivens.

The Examiner finds that "the '366 patent describes that polyalkylene glycols and polyol esters are commonly used lubricants in refrigeration machinery with hydrofluorocarbon (HFC) refrigerants (col. 6, lines 5-9)." RAN 13. In fact, the Examiner cites to an admission by Patent Owner that "ND-8 [a PAG lubricant] is one of the most widely used lubricants for automotive air conditioning systems." RAN 12 (citing Patent Owner's Supplemental Response dated November 10, 2008). The Examiner also finds that Magid and Bivens describe the use of poly alkylene glycols along with hydrofluorocarbon refrigerants. RAN 6 (citing Magid, col. 3, lines 34-40) and RAN 18 (citing Bivens, col. 1, lines 40-43). The Examiner determined that a heat transfer composition for use in air conditioning systems comprising HFO-1234yf and PAG would have been obvious to one skilled in the art because Inagaki describes the use of its refrigerants with

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lubricants and PAG is a well-known lubricant in the art. *See* RAN 6, 12, 18-19.

Patent Owner contends that Inagaki is silent as to the use of any particular lubricant, and particularly not the use of miscible lubricants such as PAG. PO App. Br. 31-32. Patent Owner argues that miscibility with any particular lubricant is not a predictable property. Patent Owner also argues that Inagaki's reference to "compatibility with lubricants" is insufficient and Inagaki's references to an oil separator and improving solubility with the addition of HCFCs and HFCs teaches away from using HFO-1234yf with a miscible lubricant. *Id.*

Accepting the recited "one liquid phase" as requiring complete miscibility between two liquids, the issue with respect to claim 21 is:

Did the Examiner err in determining that one of ordinary skill in the art would have formulated a heat transfer composition having a refrigerant and lubricant pair having the miscibility recited in claim 21 from the teachings of Inagaki and Magid, Acura and Patentee's admissions or Bivens?

Analysis

Patent Owner's arguments are not persuasive for the reasons discussed above with respect to claims 1, 3, 5, 6, 8, 11-16, 18-20, 23-25 and 31-33.

Inagaki provides evidence that HFO-1234yf is a good refrigerant, an ozone friendly refrigerant, and can be used with a lubricant. Magid, Acura, and Bivens are relied upon for demonstrating that PAG was a known lubricant for use in "air conditioning equipment," as described in Inagaki.

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The miscibility of HFO-1234yf with PAG is an inherent characteristic of HFO-1234yf, and the record provides sufficient evidence that the skilled artisan would have used HFO-1234yf with known lubricants, such as PAG. With routine testing, the skilled artisan would have had a reasonable expectation that Inagaki's unsaturated HFO compounds were miscible either with mineral oils and alkylbenzenes or alternatively with PAG and POE.

We do not agree with the Patent Owner's argument that Inagaki's teaching of combining the disclosed refrigerants with cooling machine oil in the presence of the other HFC refrigerants to "improve solubility" equates to a teaching that the combinations of lubricant and refrigerant suggested therein were immiscible. *See* PO App. Br. 32. The appealed claims use open "comprising" language and thus do not exclude the presence of other HFC materials. Thus, combinations of HFO-1234yf with other refrigerants are not excluded by the one-phase limitation. In this regard, Inagaki teaches that HFO-1234yf is capable of working as a refrigerant without the presence of the other HFCs. In fact, to the contrary, Inagaki specifically discloses that HFO-1234yf has excellent COP and freezing effect, even without the addition of other refrigerants, in the Embodiment 5 example. *See KSR*, 550 U.S. at 416 ("The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results."). Likewise, while Inagaki suggests that solubility can be "improved" with lubricants in the presence of other refrigerants, Inagaki does not indicate that solubility with lubricants of HFO-1234yf without the addition of the other refrigerants is in any way compromised or ineffective for the refrigerants use.

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Accordingly, we affirm the Examiner's rejection of claim 21 under 35 U.S.C. § 103(a) as obvious over Inagaki in view of any of Magid, Bivens, or Acura and Patentee's admission.

Claim 22

Patent Owner presents separate arguments for claim 22. *See* PO App. Br. 32-33. Claim 22 depends from claim 1 and further recites that the composition is "stable when in contact with aluminum, steel and copper under the conditions of use in refrigeration and air conditioning systems." Claim 22 stands rejected under 35 U.S.C. § 103(a) as being obvious over Inagaki in view of Magid, Acura and Patentee's admission, or Bivens.

Patent Owner contends that Inagaki is silent as to the stability of HFO-1234yf in the presence of certain metals. PO App. Br. 33. Patent Owner argues that stability is not a predictable property and would not have been expected for the reasons discussed above with respect to claims 1, 3, 5, 6, 8, 11-16, 18-20, 23-25 and 31-33. Patent Owner also relies on the evidence of secondary considerations of non-obviousness discussed above as they apply to the stability of HFO-1234yf. *Id.*

The issues presented with respect to claim 22 are substantially identical to those found unpersuasive for the reasons discussed above with respect to claims 1, 3, 5, 6, 8, 11-16, 18-20, 23-25 and 31-33. The use of HFO-1234yf as a refrigerant in air conditioning systems, and all the properties associated with the refrigerant, would have been obvious to one of ordinary skill in the art, including its compatibility with aluminum, steel and copper under the conditions of use in air conditioning systems.

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Accordingly, we affirm the rejections of claim 22 for the reasons discussed above in further detail.

Claims 36, 37, 46-49 and 75

Issue

Patent Owner presents separate arguments for claims 36, 37, 46-49 and 75. *See* PO App. Br. 34. These claims depend from claim 1 and recite that the refrigerant further comprises one or more of HFC-32, HFC-152a, propane, hexane, or octane. Moreover, these claims recite that the refrigerant “has a Global Warming Potential (GWP) of not greater than about 75” in the case of claims 37, or “has a Global Warming Potential (GWP) of not greater than about 150” in the case of claims 36, 46-49 and 75. Claims 36, 37, 46-49 and 75 stand rejected under 35 U.S.C. § 103(a) as being obvious over Inagaki in view of Magid, Acura and Patentee’s admission, or Bivens. Patent Owner argues claims 36, 37, 46-49 and 75 as a group, for which we select claim 36 as a representative claim. *See* PO App. Br. 34.

Patent Owner contends that Inagaki does not support a conclusion that a composition using a refrigerant with a GWP of less than 75 would have been obvious because there is no express disclosure of low GWP especially when considering adding saturated HFCs or HCFCs that have a high GWP. PO App. Br. 34.

The issue with respect to claims 36, 37, 46-49 and 75 is:

Did the Examiner err in determining that one of ordinary skill in the art would have formulated a heat transfer composition having a refrigerant

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comprising HFC-32, HFC-152a, propane, hexane, or octane, and further maintain the low GWP property recited in the claims from the teachings of Inagaki?

Analysis

As discussed above with respect to claims 2, 9, 10, 58 and 59, Inagaki expressly teaches the use of HFO-1234yf as a refrigerant, the use thereof, and of all the properties associated therewith, would have been obvious, including the refrigerant's low GWP. *See Atlas Powder*, 190 F.3d at 1347; RAN 55. Inagaki further expressly teaches that HFO-1234yf can be combined with other known refrigerants including "R-32 (CH₂F₂)," "R-152 (CHF₂CH₃)," and "R-152a." Inagaki 2 and 3.

Inagaki recognizes that because HFO-1234yf contains "neither chlorine atm[sic] nor bromine atom, [it has] no hazardous nature to destruct the ozone layer." Inagaki 2. Thus, Inagaki would have instructed the skilled artisan to take advantage of the environmentally friendly aspects of the refrigerants described by Inagaki. Although it would have been obvious to the skilled artisan to have combined the low GWP HFO-1234yf refrigerant with other known refrigerants that have substantially higher GWP, the skilled artisan would have had a reason and the skill to optimize the concentrations of each material to take advantage of the environmentally friendly aspects of Inagaki's refrigerants, particularly in light of national and international regulations at the time of the invention that limit the use of refrigerants with a high GWP, such as the Kyoto Protocol. *See Singh Decl.* ¶ 13 and Exhibits J and N (a 1999 conference paper stating "The regulations to come associated with the Kyoto Protocol thus create uncertainties in the

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mid to long term concerning currant refrigerants, if their GWP is high.”);

Corr Decl. ¶ 36. The skilled artisan would have optimized the concentrations of HFO-1234yf and other known refrigerants because concern for low GWP was known in the art at the time of the invention.

Accordingly, we affirm the Examiner’s rejection of claims 36, 37, 46-49 and 75 under 35 U.S.C. § 103(a) as obvious over Inagaki in view of Magid, Acura and Patentee’s admission, or Bivens.

Claims 61-68

Patent Owner presents separate arguments for claims 61-68. *See* PO App. Br. 34 and 35. Each of claims 61-68 depends from claim 1 and further recites the “one liquid phase” limitation discussed above, the GWP of “not greater than 150” limitation discussed above, and the “stable when in contact with aluminum, steel and copper” limitation discussed above. *See* claims 58 and 59, from which each of claims 61-64 depend, and claim 65. Claims 61-68 stand rejected under 35 U.S.C. § 103(a) as being obvious over Inagaki in view of Magid, Acura and Patentee’s admission, or Bivens. Claims 61-64 also stand rejected under 35 U.S.C. § 103(a) as being obvious over these reference further in view of Oberle.

Patent Owner relies on the arguments discussed above for each of these limitations separately. PO App. Br. 34 and 35. We discuss in detail above why each of these separate arguments are unpersuasive.

Accordingly, we affirm the rejections of claims 61-68 for the reasons discussed above in further detail.

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Claims 4, 7, 17, 26, 34, and 35

Issue

Patent Owner presents separate arguments for claims 4, 7, 17, 26, 34, and 35. *See* PO App. Br. 35-36. These claims recite that PAG is present in an amount of “at least about 30% to 50% by weight, depending on the claim.” *Id.* at 35. Claims 4, 7, 17, 26, 34, and 35 stand rejected under 35 U.S.C. § 103(a) as being obvious over Inagaki in view of Magid, Acura and Patentee’s admission, or Bivens. Claims 4, 7, 17, 26, 34, and 35 also stand rejected under 35 U.S.C. § 103(a) as being obvious over these reference further in view of Oberle. Patent Owner argues claims 4, 7, 17, 26, 34, and 35 as a group, for which we select claim 4 as a representative claim. *See* PO App. Br. 35-36.

Patent Owner finds that Inagaki does not describe a particular amount of any particular lubricant. *Id.* at 35. Thus, according to Patent Owner the skilled artisan would have had no reason to form a refrigerant composition having the recited PAG concentration. Patent Owner further contends that the evidence teaches away from a finding that the recited PAG concentrations would have been obvious at the time of the invention. PO App. Br. 35-36.

The issue with respect to claims 4, 7, 17, 26, 34, and 35 is:

Did the Examiner err in determining that one of ordinary skill in the art would have had a reason to formulate a heat transfer composition having a refrigerant and PAG in the concentration ranges recited in the claims from the teachings of Inagaki, Magid, Acura and Patentee’s admissions, Biven or Oberle?

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Analysis

The Examiner determines that it would have been obvious for one of ordinary skill in the art to have discovered the optimum or workable ranges for PAG concentration by routine experimentation. *See* RAN 6-7, 13, 19 (citing *Peterson*, 315 F.3d at 1330 (“The normal desire of scientists or artisans to improve upon what is already generally known provides the motivation to determine where in a disclosed set of percentage ranges is the optimum combination of percentages.”); *Aller*, 220 F.2d at 456 (“[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.”)). Moreover, the Examiner indicates that, to the extent the claimed concentration of lubricant is not specifically taught, Oberle teaches a refrigerant lubricant pair in which a lubricant, including PAG, is provided preferably within a range of 0.3-50% by weight. RAN 9-10, 16-17, and 22 (citing Oberle, col. 22, ll. 1-4; *see also* col. 12, ll. 16-23). The Examiner thus determines that it would have been obvious for the skilled artisan to have used the HFO-1234yf/PAG composition in the lubricant concentrations described in Oberle, as representative of the known range of lubricant concentrations in refrigerant/lubricant compositions. *Id.*

For the reasons discussed above, we agree with the Examiner that it would have been obvious to the skilled artisan to combine HFO-1234yf as taught by Inagaki with PAG, particularly ND-8, as taught by Magid, Bivens, and Acura and Patentee’s admissions. We further find that determining optimal concentration ranges of these two components was within the skill of the ordinary artisan. Optimization of a variable which is recognized in

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the prior art to be a result effective variable would ordinarily be within the skill in the art. *In re Boesch*, 617 F.2d 272, 276 (CCPA 1980); *see also In re Aller*, 220 F.2d 454, 456 (CCPA 1955) (“where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.”). An improvement in the art is obvious if “it is likely the product not of innovation but of ordinary skill and common sense.” *KSR Int’l v. Teleflex Inc.*, 550 U.S. 398, 402-403 (2007). Patent Owner has not shown that such optimization is outside of the skill of the ordinary artisan or that the claimed concentration range of 30% to 50% by weight is critical or exhibits unexpected or superior properties over the improvement that would have been expected due to routine optimization. *See Boesch*, 617 F.2d at 276; *In re Woodruff*, 919 F.2d at 1578; *Aller*, 220 F.2d at 456.

Further, Oberle describes lubricants used in a concentration range that encompasses the recited concentration range. It has been often said that when a claimed range overlaps, is close to, or within a broader range disclosed in the prior art, the claimed range is prima facie obvious. *Iron Grip Barbell v USA Sports, Inc.*, 392 F.3d 1317, 1321-22 (Fed. Cir. 2004). When “‘the difference between the claimed invention and the prior art is the range or value of a particular variable,’ then a patent should not issue if ‘the difference in range or value is minor.’” *Haynes Int’l v. Jessop Steel Co.*, 8 F.3d 1573, 1577 n.3 (Fed. Cir. 1993); *see also Titanium Metals Corp. of Am. v. Banner*, 778 F.2d 775, 783 (Fed. Cir. 1985).” *Iron Grip*, 392 F.3d at 1322. Patent Owner has not persuasively shown that the narrower concentration teaching of Oberle would not have suggested a concentration

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range for PAG to be used with HFO-1234yf, as taught by Inagaki and Magid, Bivens, and Acura and Patentee's admissions.

Additionally, we are not persuaded by Patent Owner's argument that the statements of Dr. Corr in his deposition teach away from the obviousness of the claimed concentration range. The relevant portion of Dr. Corr's testimony is as follows:

A. I wouldn't think it was obvious to add 50 percent of oil to a refrigerant composition and have it -- have it working well of 30 to 50 percent.

Q. So you wouldn't think it was obvious to 30 to 50 percent lubricant and having it working well, correct?

A. In terms of that as a heat transfer medium, no.

Q. Okay. Okay. That's it on your declaration.

A. Just to make it clear, when I'm talking about obvious and saying I don't think it's obvious from claims 5, for instance, to add 50 percent, that's from a skilled person's point of view. There's no any kind of taint from any kind of legal reading.

Corr Deposition, from IPR2013-00576, taken April 24, 2014, 269:14-270:4

We have considered Dr. Corr's testimony. However, without an explanation of the reasoning behind this conclusion vis-à-vis the teaching of Oberle, which teaches that it was known in the art to use PAG within the recited range, we find Dr. Corr's testimony insufficient to outweigh the disclosures of the prior art. *See Rohm and Haas Co. v. Brotech Corp.*, 127 F.3d 1089, 1092 (Fed. Cir. 1997) ("Nothing in the rules or in our jurisprudence requires the fact finder to credit the unsupported assertions of an expert witness."); *In re Thompson*, 545 F.2d 1290, 1295 (CCPA 1980)

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(affidavit “sets forth no specifics and falls far short of constituting probative evidence.”).

Accordingly, we affirm the Examiner’s rejection of claims 4, 7, 17, 26, 34, and 35 under 35 U.S.C. § 103(a) as obvious over Inagaki in view of Magid, Acura and Patentee’s admission, or Bivens or under U.S.C. § 103(a) as obvious over these references further in view of Oberle.

Claim 70

Issue

Patent Owner presents separate arguments for claim 70. *See* PO App. Br. 36. Claim 70 recites that the refrigerant further comprises one or more of HFC-32, HFC-152a, propane, hexane, or octane. Moreover, these claims recite that the composition is “nonflammable.” Claim 70 stands rejected under 35 U.S.C. § 103(a) as being obvious over Inagaki in view of Magid, Acura and Patentee’s admission, or Bivens.

Patent Owner contends that Inagaki, which is silent as to flammability, does not support a conclusion that a nonflammable composition would have been obvious, particularly when considering adding highly flammable alkanes, because flammability of combinations of refrigerants is unpredictable. PO App. Br. 34.

The issue with respect to claim 70 is:

Did the Examiner err in determining that one of ordinary skill in the art would have formulated a heat transfer composition having a refrigerant comprising HFC-32, HFC-152a, propane, hexane, or octane, and further

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have maintained the “nonflammable” property recited in the claims from the teachings of Inagaki?

Analysis

Inagaki evinces that at the time of the invention HFO-1234yf would have been known to those of skill in the art to be a refrigerant with good COP and good freezing effect with no destructive effects on the ozone layer. We find it of no moment that Inagaki also discloses other refrigerants that are less desirable due to flammability. *See Merck*, 874 F.2d at 807. As discussed above with respect to toxicity, HFO-1234yf also exhibits the desirable property of low flammability. Thus, despite the fact that HFO-1234yf, a known refrigerant, possessed attributes (e.g., low flammability) that were yet to be recognized in the art, the compound would have been recognized as suitable for use in air conditioning equipment, an application for refrigerants which is also taught by Inagaki.

The properties of the particular refrigerants are inherent to the refrigerant, whether specifically disclosed or not. Such inherent properties of refrigerants include flammability. One cannot obtain patentability based on these inherent properties of an otherwise known refrigerant. The new realization alone does not render that prior art patentable.

Also as discussed above, we are not persuaded that any of the cited potential difficulties or problems associated with the use of HFO-1234yf, such as flammability, would have deterred an ordinary artisan from using HFO-1234yf as a refrigerant, as evidenced by Inagaki. In other words, based on Inagaki, an ordinary artisan would have had reason to predict that Inagaki’s refrigerants would have worked as intended, i.e., causing heat to

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be transferred from the air being cooled to the heat transfer composition by vaporizing the refrigerant, as recited in the claims. Even if HFO-1234yf had been expected to be flammable, the skilled artisan would have recognized the tradeoff of some flammability for the benefits of good cooling with little effect on the ozone, and would have had reason to use Inagaki's refrigerants in air conditioning equipment accordingly, as taught by Inagaki. *See* Singh Decl. ¶ 14 (citing Exhibit K, which is a 1997 ASHRE conference paper entitled "Trade-Offs in Refrigerant Selections."); Singh Decl. ¶ 13, Exhibit G and First Bivens Decl. ¶ 9, n. 4, Exhibit F (a 1987 ASHRE journal article entitled "*Quest for Alternatives: A Molecular Approach Demonstrates Tradeoffs and Limitations Are Inevitable in Seeking Refrigerants*").

Although it would have been obvious to the skilled artisan to have combined the HFO-1234yf refrigerant with other known refrigerants that have substantially higher flammability, the skilled artisan would have a reason and the skill to optimize the concentrations of each material to minimize the flammability, particularly because the particular issues with respect to flammability were known in the art at the time of the invention and the testing of prospective refrigerants for these properties was routine in the art at the time of the invention. *Id.*

Accordingly, we affirm the Examiner's rejection of claim 70 under 35 U.S.C. § 103(a) as obvious over Inagaki in view of Magid, Acura and Patentee's admission, or Bivens.

DECISION

In sum, we affirm all of the Examiner's rejections on appeal.

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TIME PERIOD FOR RESPONSE

In accordance with 37 C.F.R. § 41.79(a)(1), the “[p]arties to the appeal may file a request for rehearing of the decision within one month of the date of: . . . [t]he original decision of the Board under § 41.77(a).” A request for rehearing must be in compliance with 37 C.F.R. § 41.79(b). Comments in opposition to the request and additional requests for rehearing must be in accordance with 37 C.F.R. § 41.79(c) & (d), respectively. Under 37 C.F.R. § 41.79(e), the times for requesting rehearing under paragraph (a) of this section, for requesting further rehearing under paragraph (d) of this section, and for submitting comments under paragraph (c) of this section may not be extended.

An appeal to the United States Court of Appeals for the Federal Circuit under 35 U.S.C. §§ 141–144 and 315 and 37 C.F.R. § 1.983 for an *inter partes* reexamination proceeding “commenced” on or after November 2, 2002 may not be taken “until all parties' rights to request rehearing have been exhausted, at which time the decision of the Board is final and appealable by any party to the appeal to the Board.” 37 C.F.R. § 41.81. *See also* MPEP § 2682 (8th ed., Rev. 7, July 2008).

AFFIRMED

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(12) **United States Patent**
Singh et al.

(10) **Patent No.:** **US 7,534,366 B2**
(45) **Date of Patent:** **May 19, 2009**

(54) **COMPOSITIONS CONTAINING FLUORINE
SUBSTITUTED OLEFINS**

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(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 41 days.

(21) Appl. No.: **10/694,273**

(22) Filed: **Oct. 27, 2003**

(65) **Prior Publication Data**

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Related U.S. Application Data

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25, 2002, provisional application No. 60/421,435,
filed on Oct. 25, 2002.

(51) **Int. Cl.**
C09K 5/04 (2006.01)

(52) **U.S. Cl.** **252/68**; 252/67; 252/69;
252/71; 252/74

(58) **Field of Classification Search** 252/68,
252/67, 69, 71, 74
See application file for complete search history.

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(57) **ABSTRACT**

The use of pentafluoropropene (HFO-1225) and tetrafluoro-
propene (HFO-1234) in refrigeration equipment is disclosed.
These materials are generally useful as refrigerants for heat-
ing and cooling, as blowing agents, as aerosol propellants, as
solvent composition, and as fire extinguishing and suppress-
ing agents.

25 Claims, No Drawings

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**COMPOSITIONS CONTAINING FLUORINE
SUBSTITUTED OLEFINS****RELATED APPLICATIONS**

The present application is related to and claims the priority benefit of U.S. Provisional Application Nos. 60/421,263, and 60/421,435, each of which was filed on Oct. 25, 2002, and each of which is incorporated herein by reference. The present application is also related to and incorporates by reference each of the following concurrently filed United States Patent Applications: entitled "Fluorinated Alkene Refrigerant Composition," by Raymond Thomas and Rajiv Singh, application Ser. No. 10/695,212, now abandoned in favor of application Ser. No. 11/385,259, now pending, and entitled "Process For Producing Fluoropropenes," by Hsueh Sung Tung et al, application Ser. No. 10/694,272, which issued as U.S. Pat. No. 7,230,146.

FIELD OF THE INVENTION

This invention relates to compositions having utility in numerous applications, including particularly refrigeration systems, and to methods and systems which utilize such compositions. In preferred aspects, the present invention is directed to refrigerant compositions which comprise at least one multi-fluorinated olefin of the present invention.

BACKGROUND OF THE INVENTION

Fluorocarbon based fluids have found widespread use in many commercial and industrial applications. For example, fluorocarbon based fluids are frequently used as a working fluid in systems such as air conditioning, heat pump and refrigeration applications. The vapor compression cycle is one of the most commonly used type methods to accomplish cooling or heating in a refrigeration system. The vapor compression cycle usually involves the phase change of the refrigerant from the liquid to the vapor phase through heat absorption at a relatively low pressure and then from the vapor to the liquid phase through heat removal at a relatively low pressure and temperature, compressing the vapor to a relatively elevated pressure, condensing the vapor to the liquid phase through heat removal at this relatively elevated pressure and temperature, and then reducing the pressure to start the cycle over again.

While the primary purpose of refrigeration is to remove heat from an object or other fluid at a relatively low temperature, the primary purpose of a heat pump is to add heat at a higher temperature relative to the environment.

Certain fluorocarbons have been a preferred component in many heat exchange fluids, such as refrigerants, for many years in many applications. For, example, fluoroalkanes, such as chlorofluoromethane and chlorofluoroethane derivatives, have gained widespread use as refrigerants in applications including air conditioning and heat pump applications owing to their unique combination of chemical and physical properties. Many of the refrigerants commonly utilized in vapor compression systems are either single components fluids or azeotropic mixtures.

Concern has increased in recent years about potential damage to the earth's atmosphere and climate, and certain chlorine-based compounds have been identified as particularly problematic in this regard. The use of chlorine-containing compositions (such as chlorofluorocarbons (CFC's), hydrochlorofluorocarbons (HCF's) and the like) as refrigerants in air-conditioning and refrigeration systems has become disfa-

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vored because of the ozone-depleting properties associated with many of such compounds. There has thus been an increasing need for new fluorocarbon and hydrofluorocarbon compounds and compositions that offer alternatives for refrigeration and heat pump applications. For example, it has become desirable to retrofit chlorine-containing refrigeration systems by replacing chlorine-containing refrigerants with non-chlorine-containing refrigerant compounds that will not deplete the ozone layer, such as hydrofluorocarbons (HFC's).

It is generally considered important, however, that any potential substitute refrigerant must also possess those properties present in many of the most widely used fluids, such as excellent heat transfer properties, chemical stability, low- or no-toxicity, non-flammability and lubricant compatibility, among others.

Applicants have come to appreciate that lubricant compatibility is of particular importance in many of applications. More particularly, it is highly desirably for refrigeration fluids to be compatible with the lubricant utilized in the compressor unit, used in most refrigeration systems. Unfortunately, many non-chlorine-containing refrigeration fluids, including HFC's, are relatively insoluble and/or immiscible in the types of lubricants used traditionally with CFC's and HFC's, including, for example, mineral oils, alkylbenzenes or poly (alpha-olefins). In order for a refrigeration fluid-lubricant combination to work at a desirable level of efficiency within a compression refrigeration, air-conditioning and/or heat pump system, the lubricant should be sufficiently soluble in the refrigeration liquid over a wide range of operating temperatures. Such solubility lowers the viscosity of the lubricant and allows it to flow more easily throughout the system. In the absence of such solubility, lubricants tend to become lodged in the coils of the evaporator of the refrigeration, air-conditioning or heat pump system, as well as other parts of the system, and thus reduce the system efficiency.

With regard to efficiency in use, it is important to note that a loss in refrigerant thermodynamic performance or energy efficiency may have secondary environmental impacts through increased fossil fuel usage arising from an increased demand for electrical energy.

Furthermore, it is generally considered desirably for CFC refrigerant substitutes to be effective without major engineering changes to conventional vapor compression technology currently used with CFC refrigerants.

Flammability is another important property for many applications. That is, it is considered either important or essential in many applications, including particularly in heat transfer applications, to use compositions which are non-flammable. Thus, it is frequently beneficial to use in such compositions compounds which are nonflammable. As used herein, the term "nonflammable" refers to compounds or compositions which are determined to be nonflammable as determined in accordance with ASTM standard E-681, dated 2002, which is incorporated herein by reference. Unfortunately, many HFC's which might otherwise be desirable for used in refrigerant compositions are not nonflammable. For example, the fluoroalkane difluoroethane (HFC-152a) and the fluoroalkene 1,1,1-trifluorpropene (HFO-1243zf) are each flammable and therefore not viable for use in many applications.

Higher fluoroalkenes, that is fluorine-substituted alkenes having at least five carbon atoms, have been suggested for use as refrigerants. U.S. Pat. No. 4,788,352—Smutny is directed to production of fluorinated C₅ to C₈ compounds having at least some degree of unsaturation. The Smutny patent identifies such higher olefins as being known to have utility as

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refrigerants, pesticides, dielectric fluids, heat transfer fluids, solvents, and intermediates in various chemical reactions. (See column 1, lines 11-22).

While the fluorinated olefins described in Smutny may have some level of effectiveness in heat transfer applications, it is believed that such compounds may also have certain disadvantages. For example, some of these compounds may tend to attack substrates, particularly general-purpose plastics such as acrylic resins and ABS resins. Furthermore, the higher olefinic compounds described in Smutny may also be undesirable in certain applications because of the potential level of toxicity of such compounds which may arise as a result of pesticide activity noted in Smutny. Also, such compounds may have a boiling point which is too high to make them useful as a refrigerant in certain applications.

Bromofluoromethane and bromochlorofluoromethane derivatives, particularly bromotrifluoromethane (Halon 1301) and bromochlorodifluoromethane (Halon 1211) have gained widespread use as fire extinguishing agents in enclosed areas such as airplane cabins and computer rooms. However, the use of various halons is being phased out due to their high ozone depletion. Moreover, as halons are frequently used in areas where humans are present, suitable replacements must also be safe to humans at concentrations necessary to suppress or extinguish fire.

Applicants have thus come to appreciate a need for compositions, and particularly heat transfer compositions, fire extinguishing/suppression compositions, blowing agents, solvent compositions, and compatibilizing agents, that are potentially useful in numerous applications, including vapor compression heating and cooling systems and methods, while avoiding one or more of the disadvantages noted above.

SUMMARY

Applicants have found that the above-noted need, and other needs, can be satisfied by compositions comprising one or more C3 or C4 fluoroalkenes, preferably compounds having Formula I as follows:



where X is a C₂ or a C₃ unsaturated, substituted or unsubstituted, alkyl radical, each R is independently Cl, F, Br, I or H, and z is 1 to 3.

The present invention provides also methods and systems which utilize the compositions of the present invention, including methods and systems for heat transfer, foam blowing, solvating, and aerosol generation.

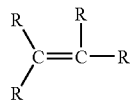
DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The Compositions

The present invention is directed to compositions comprising at least one fluoroalkene containing from 3 to 4 carbon atoms and at least one carbon-carbon double bond. The fluoroalkene compounds of the present invention are sometimes referred to herein for the purpose of convenience as hydrofluoro-olefins or "HFOs" if they contain at least one hydrogen. Although it is contemplated that the HFOs of the present invention mentioned may contain two carbon-carbon double bonds, such compounds at the present time are not considered to be preferred.

As mentioned above, the present compositions comprise one or compounds in accordance with Formula I. In preferred embodiments, the compositions include compounds of Formula II below:

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where each R is independently Cl, F, Br, I or H

R' is (CR₂)_nY,

Y is CRF₂

and n is 0 or 1.

In highly preferred embodiments, Y is CF₃, n is 0 and at least one of the remaining Rs is F.

Applicants believe that, in general, the compounds of the above identified Formulas I and II are generally effective and exhibit utility in refrigerant compositions, blowing agent compositions, compatibilizers, and solvent compositions of the present invention. However, applicants have surprisingly and unexpectedly found that certain of the compounds having a structure in accordance with the formulas described above exhibit a highly desirable low level of toxicity compared to other of such compounds. As can be readily appreciated, this discovery is of potentially enormous advantage and benefit for the formulation of not only refrigerant compositions, but also any and all compositions which would otherwise contain relatively toxic compounds satisfying the formulas described above. More particularly, applicants believe that a relatively low toxicity level is associated with compounds of Formula II, preferably wherein Y is CF₃, wherein at least one R on the unsaturated terminal carbon is H, and at least one of the remaining Rs is F. Applicants believe also that all structural, geometric and stereoisomers of such compounds are effective and of beneficially low toxicity.

In highly preferred embodiments, especially embodiments which comprise the low toxicity compounds described above, n is zero. Thus, in certain preferred embodiments the compositions of the present invention comprise one or more compounds selected from the group consisting of tetrafluoropropenes (HFO-1234), pentafluoropropenes (HFO-1225) and combinations of these.

It is even more preferred that the compounds of the present invention are the tetrafluoropropene and pentafluoropropene compounds in which the unsaturated terminal carbon has not more than one F substituent, specifically: 1,3,3,3-tetrafluoropropene (HFO-1234ze); 2,3,3,3-tetrafluoropropene (HFO-1234yf); and 1,2,3,3,3-pentafluoropropene (HFO-1225ye), and any and all stereoisomers of each of these. Applicant has discovered that such compounds have a very low acute toxicity level, as measured by inhalation exposure to mice and rats. On the other hand, applicants have found that a relatively high degree of toxicity may be associated with certain compounds adaptable for use with the present compositions, namely, those compounds which have more than one F on the terminal unsaturated carbon, or which do not have at least one H on the terminal unsaturated carbon. For example, applicants have discovered that 1,1,3,3,3-pentafluoropropene (HFO-1225zc) exhibits an unacceptably high degree of toxicity, as measured by inhalation exposure to mice and rats.

The preferred compounds of the present invention, namely, HFO-1225 and HFO-1234 are known materials and are listed in Chemical Abstracts databases. HFO-1225 is commercially available, from example from Syntex Chemical Co. Furthermore, methods are described generally in the patent literature for producing fluoroalkenes. For example, the production of fluoropropenes such as CF₃CH=CH₂ by catalytic vapor

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phase fluorination of various saturated and unsaturated halogen-containing C_3 compounds is described in U.S. Pat. Nos. 2,889,379; 4,798,818 and 4,465,786, each of which is incorporated herein by reference. U.S. Pat. No. 5,532,419, which is also incorporated herein by reference, discloses a vapor phase catalytic process for the preparation of fluoroalkene using a chloro- or bromo-halo fluorocarbon and HF. EP 974,571, also incorporated herein by reference, discloses the preparation of 1,1,1,3-tetrafluoropropene by contacting 1,1,1,3,3-pentafluoropropane (HFC-245fa) in the vapor phase with a chromium-based catalyst at elevated temperature, or in the liquid phase with an alcoholic solution of KOH, NaOH, $Ca(OH)_2$ or $Mg(OH)_2$. In addition, methods for producing compounds in accordance with the present invention are described generally in connection with concurrently filed U.S. patent application Ser. No. 10/694,272 entitled "Process for Producing Fluoropropenes" which is also incorporated herein by reference.

The present compositions are believed to possess properties that are advantageous for a number of important reasons. For example, applicants believe, based at least in part on mathematical modeling, that the fluoroolefins of the present invention will not have a substantial negative effect on atmospheric chemistry, being negligible contributors to ozone depletion in comparison to some other halogenated species. The preferred compositions of the present invention thus have the advantage of not contributing substantially to ozone depletion. The preferred compositions also do not contribute substantially to global warming compared to many of the hydrofluoroalkanes presently in use.

Preferably, the compositions of the present invention have a Global Warming Potential (GWP) of not greater than 150, more preferably not greater than 100 and even more preferably not greater than 75. As used herein, "GWP" is measured relative to that of carbon dioxide and over a 100 year time horizon, as defined in "The Scientific Assessment of Ozone Depletion, 2002, a report of the World Meteorological Association's Global Ozone Research and Monitoring Project," which is incorporated herein by reference.

The present compositions also preferably have an Ozone Depletion Potential (ODP) of not greater than 0.05, more preferably not greater than 0.02 and even more preferably about zero. As used herein, "ODP" is as defined in "The Scientific Assessment of Ozone Depletion, 2002, A report of the World Meteorological Association's Global Ozone Research and Monitoring Project," which is incorporated herein by reference.

Heat Transfer Compositions

Although it is contemplated that the compositions of the present invention may include the compounds of the present invention in widely ranging amounts, it is generally preferred that refrigerant compositions of the present invention comprise compound(s) in accordance with Formula I, and even more preferably Formula II, in an amount that is at least about 50% by weight, and even more preferably at least about 70% by weight, of the composition.

The compositions of the present invention may include other components for the purpose of enhancing or providing certain functionality to the composition, or in some cases to reduce the cost of the composition. For example, refrigerant compositions according to the present invention, especially those used in vapor compression systems, include a lubricant, generally in amounts of from about 30 to about 50 percent by weight of the composition. Furthermore, the present compositions may also include a compatibilizer, such as propane, for the purpose of aiding compatibility and/or solubility of the lubricant. Such compatibilizers, including propane, butanes and pentanes, are preferably present in amounts of from about

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0.5 to about 5 percent by weight of the composition. Combinations of surfactants and solubilizing agents may also be added to the present compositions to aid oil solubility, as disclosed by U.S. Pat. No. 6,516,837, the disclosure of which is incorporated by reference. Commonly used refrigeration lubricants such as Polyol Esters (POEs) and Poly Alkylene Glycols (PAGs) that are used in refrigeration machinery with hydrofluorocarbon (HFC) refrigerants may be used with the refrigerant compositions of the present invention.

The polyalkylene glycol lubricants suitable for use with the present invention typically containing from about 5 to 50 oxyalkylene repeating units that contain from 1 to 5 carbon atoms. The polyalkylene glycol can be straight chain or branched and can be a homopolymer or co-polymer of 2, 3 or more oxyethylene, oxypropylene, oxybutylene or oxypentylene groups or combinations thereof in any proportions. Preferred polyalkylene glycols contain at least 50% oxypentylene groups. Compositions according to the present invention may contain one or more polyalkylene glycols as the lubricant, one or more polyalkylene glycol esters as the lubricant, or a mixture of one or more polyalkylene glycols and one or more polyalkylene glycol esters. Vinyl ethers are also useful in this invention. While suitable polyalkylene glycols include glycols terminating at each end with a hydroxyl group, other suitable HFO lubricants include polyalkylene glycols in which either or both terminal hydroxyl group is capped. The hydroxyl group may be capped with alkyl groups containing from 1 to 10 carbon atoms, 1 to 10 carbon atom alkyl groups containing heteroatoms such as nitrogen. In preferred embodiments, the lubricants of this invention have viscosities of from about 1 to 1000 centistokes at about 37° C., more preferably in the range of from about 10 to about 200 centistokes at about 37° C. and even more preferably of from about 30 to about 150 centistokes.

Blowing Agents, Foams and Foamable Compositions

Blowing agents may also comprise or constitute one or more of the present compositions. As mentioned above, the compositions of the present invention may include the compounds of the present invention in widely ranging amounts. It is generally preferred, however, that for preferred compositions for use as blowing agents in accordance with the present invention, compound(s) in accordance with Formula I, and even more preferably Formula II, are present in an amount that is at least about 5% by weight, and even more preferably at least about 15% by weight, of the composition.

In other embodiments, the invention provides foamable compositions, and preferably polyurethane, polyisocyanurate and extruded thermoplastic foam compositions, prepared using the compositions of the present invention. In such foam embodiments, one or more of the present compositions are included as or part of a blowing agent in a foamable composition, which composition preferably includes one or more additional components capable of reacting and/or foaming under the proper conditions to form a foam or cellular structure, as is well known in the art. The invention also relates to foam, and preferably closed cell foam, prepared from a polymer foam formulation containing a blowing agent comprising the compositions of the invention. In yet another embodiment, the invention provides a foamable composition comprising thermoplastic foams, such as polystyrene and polyethylene (PE), preferably low density PE.

In certain preferred embodiments, dispersing agents, cell stabilizers, surfactants and other additives may also be incorporated into the blowing agent compositions of the present invention. Surfactants are optionally but preferably added to serve as cell stabilizers. Some representative materials are sold under the names of DC-193, B-8404, and L-5340 which

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are, generally, polysiloxane polyoxyalkylene block co-polymers such as those disclosed in U.S. Pat. Nos. 2,834,748, 2,917,480, and 2,846,458, each of which is incorporated herein by reference. Other optional additives for the blowing agent mixture may include flame retardants such as tri(2-chloroethyl)phosphate, tri(2-chloropropyl)phosphate, tri(2,3-dibromopropyl)-phosphate, tri(1,3-dichloropropyl) phosphate, diammonium phosphate, various halogenated aromatic compounds, antimony oxide, aluminum trihydrate, polyvinyl chloride, and the like.

Propellant Compositions

In another aspect, the present invention provided propellant compositions comprising or consisting essentially of a composition of the present invention, such propellant composition preferably being a sprayable composition. The propellant compositions of the present invention preferably comprise a material to be sprayed and a propellant comprising, consisting essentially of, or consisting of a composition in accordance with the present invention. Inert ingredients, solvents, and other materials may also be present in the sprayable mixture. Preferably, the sprayable composition is an aerosol. Suitable materials to be sprayed include, without limitation, cosmetic materials such as deodorants, perfumes, hair sprays, cleansers, and polishing agents as well as medicinal materials such as anti-asthma and anti-halitosis medications.

Methods and Systems

The compositions of the present invention are useful in connection with numerous methods and systems, including as heat transfer fluids in methods and systems for transferring heat, such as refrigerants used in refrigeration, air conditioning and heat pump systems. The present compositions are also advantageous for in use in systems and methods of generating aerosols, preferably comprising or consisting of the aerosol propellant in such systems and methods. Methods of forming foams and methods of extinguishing and suppressing fire are also included in certain aspects of the present invention. The present invention also provides in certain aspects methods of removing residue from articles in which the present compositions are used as solvent compositions in such methods and systems.

Heat Transfer Methods

The preferred heat transfer methods generally comprise providing a composition of the present invention and causing heat to be transferred to or from the composition changing the phase of the composition. For example, the present methods provide cooling by absorbing heat from a fluid or article, preferably by evaporating the present refrigerant composition in the vicinity of the body or fluid to be cooled to produce vapor comprising the present composition. Preferably the methods include the further step of compressing the refrigerant vapor, usually with a compressor or similar equipment to produce vapor of the present composition at a relatively elevated pressure. Generally, the step of compressing the vapor results in the addition of heat to the vapor, thus causing an increase in the temperature of the relatively high pressure vapor. Preferably, the present methods include removing from this relatively high temperature, high pressure vapor at least a portion of the heat added by the evaporation and compression steps. The heat removal step preferably includes condensing the high temperature, high pressure vapor while the vapor is in a relatively high pressure condition to produce a relatively high pressure liquid comprising a composition of the present invention. This relatively high pressure liquid preferably then undergoes a nominally isenthalpic reduction in pressure to produce a relatively low temperature, low pressure liquid. In such embodiments, it is this reduced tempera-

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ture refrigerant liquid which is then vaporized by heat transferred from the body or fluid to be cooled.

In another process embodiment of the invention, the compositions of the invention may be used in a method for producing heating which comprises condensing a refrigerant comprising the compositions in the vicinity of a liquid or body to be heated. Such methods, as mentioned hereinbefore, frequently are reverse cycles to the refrigeration cycle described above.

Foam Blowing Methods

One embodiment of the present invention relates to methods of forming foams, and preferably polyurethane and polyisocyanurate foams. The methods generally comprise providing a blowing agent composition of the present inventions, adding (directly or indirectly) the blowing agent composition to a foamable composition, and reacting the foamable composition under the conditions effective to form a foam or cellular structure, as is well known in the art. Any of the methods well known in the art, such as those described in "Polyurethanes Chemistry and Technology," Volumes I and II, Saunders and Frisch, 1962, John Wiley and Sons, New York, N.Y., which is incorporated herein by reference, may be used or adapted for use in accordance with the foam embodiments of the present invention. In general, such preferred methods comprise preparing polyurethane or polyisocyanurate foams by combining an isocyanate, a polyol or mixture of polyols, a blowing agent or mixture of blowing agents comprising one or more of the present compositions, and other materials such as catalysts, surfactants, and optionally, flame retardants, colorants, or other additives.

It is convenient in many applications to provide the components for polyurethane or polyisocyanurate foams in pre-blended formulations. Most typically, the foam formulation is pre-blended into two components. The isocyanate and optionally certain surfactants and blowing agents comprise the first component, commonly referred to as the "A" component. The polyol or polyol mixture, surfactant, catalysts, blowing agents, flame retardant, and other isocyanate reactive components comprise the second component, commonly referred to as the "B" component. Accordingly, polyurethane or polyisocyanurate foams are readily prepared by bringing together the A and B side components either by hand mix for small preparations and, preferably, machine mix techniques to form blocks, slabs, laminates, pour-in-place panels and other items, spray applied foams, froths, and the like. Optionally, other ingredients such as fire retardants, colorants, auxiliary blowing agents, and even other polyols can be added as a third stream to the mix head or reaction site. Most preferably, however, they are all incorporated into one B-component as described above.

It is also possible to produce thermoplastic foams using the compositions of the invention. For example, conventional polystyrene and polyethylene formulations may be combined with the compositions in a conventional manner to produce rigid foams.

Cleaning Methods

The present invention also provides methods of removing contaminants from a product, part, component, substrate, or any other article or portion thereof by applying to the article a composition of the present invention. For the purposes of convenience, the term "article" is used herein to refer to all such products, parts, components, substrates, and the like and is further intended to refer to any surface or portion thereof. Furthermore, the term "contaminant" is intended to refer to any unwanted material or substance present on the article, even if such substance is placed on the article intentionally. For example, in the manufacture of semiconductor devices it

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is common to deposit a photoresist material onto a substrate to form a mask for the etching operation and to subsequently remove the photoresist material from the substrate. The term "contaminant" as used herein is intended to cover and encompass such a photo resist material.

Preferred methods of the present invention comprise applying the present composition to the article, with vapor degreasing and solvent cleaning methods being particularly preferred for certain applications, especially those intricate parts and difficult to remove soils. Preferred vapor degreasing and solvent cleaning methods consist of exposing an article, preferably at room-temperature, to the vapors of a boiling solvent. Vapors condensing on the object have the advantage of providing a relatively clean, distilled solvent to wash away grease or other contamination. Such processes thus have an additional advantage in that final evaporation of the present solvent composition from the object leaves behind relatively little residue as compared to the case where the object is simply washed in liquid solvent.

For applications in which the article includes contaminants that are difficult to remove, it is preferred that the present methods involve raising the temperature of the solvent composition of the present invention above ambient or to any other temperature that is effective in such application to substantially improve the cleaning action of the solvent. Such processes are also generally preferred for large volume assembly line operations where the cleaning of the article, particularly metal parts and assemblies, must be done efficiently and quickly.

In preferred embodiments, the cleaning methods of the present invention comprise immersing the article to be cleaned in liquid solvent at an elevated temperature, and even more preferably at about the boiling point of the solvent. In such operations, this step preferably removes a substantial amount, and even more preferably a major portion, of the target contaminant from the article. This step is then preferably followed by immersing the article in solvent, preferably freshly distilled solvent, which is at a temperature below the temperature of the liquid solvent in the preceding immersion step, preferably at about ambient or room temperature. The preferred methods also include the step of then contacting the article with relatively hot vapor of the present solvent composition, preferably by exposing the article to solvent vapors rising from the hot/boiling solvent associated with the first mentioned immersion step. This preferably results in condensation of the solvent vapor on the article. In certain preferred embodiments, the article may be sprayed with distilled solvent before final rinsing.

It is contemplated that numerous varieties and types of vapor degreasing equipment are adaptable for use in connection with the present methods. One example of such equipment and its operation is disclosed by Sherliker et al. in U.S. Pat. No. 3,085,918, which is incorporated herein by reference. The equipment disclosed in Sherliker et al includes a boiling sump for containing a solvent composition, a clean sump for containing distilled solvent, a water separator, and other ancillary equipment.

The present cleaning methods may also comprise cold cleaning in which the contaminated article is either immersed in the fluid composition of the present invention under ambient or room temperature conditions or wiped under such conditions with rags or similar objects soaked in solvents.

Flammability Reduction Methods

According to certain other preferred embodiments, the present invention provides methods for reducing the flammability of fluids, said methods comprising adding a compound or composition of the present invention to said fluid. The

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flammability associated with any of a wide range of otherwise flammable fluids may be reduced according to the present invention. For example, the flammability associated with fluids such as ethylene oxide, flammable hydrofluorocarbons and hydrocarbons, including: HFC-152a, 1,1,1-trifluoroethane (HFC-143a), difluoromethane (HFC-32), propane, hexane, octane, and the like can be reduced according to the present invention. For the purposes of the present invention, a flammable fluid may be any fluid exhibiting flammability ranges in air as measured via any standard conventional test method, such as ASTM E-681, and the like.

Any suitable amounts of the present compounds or compositions may be added to reduce flammability of a fluid according to the present invention. As will be recognized by those of skill in the art, the amount added will depend, at least in part, on the degree to which the subject fluid is flammable and the degree to which it is desired to reduce the flammability thereof. In certain preferred embodiments, the amount of compound or composition added to the flammable fluid is effective to render the resulting fluid substantially non-flammable.

Flame Suppression Methods

The present invention further provides methods of suppressing a flame, said methods comprising contacting a flame with a fluid comprising a compound or composition of the present invention. Any suitable methods for contacting the flame with the present composition may be used. For example, a composition of the present invention may be sprayed, poured, and the like onto the flame, or at least a portion of the flame may be immersed in the composition. In light of the teachings herein, those of skill in the art will be readily able to adapt a variety of conventional apparatus and methods of flame suppression for use in the present invention.

Sterilization Methods

Many articles, devices and materials, particularly for use in the medical field, must be sterilized prior to use for the health and safety reasons, such as the health and safety of patients and hospital staff. The present invention provides methods of sterilizing comprising contacting the articles, devices or material to be sterilized with a compound or composition of the present invention. Such methods may be either high or low-temperature sterilization methods. In certain embodiments, high-temperature sterilization comprises exposing the articles, device or material to be sterilized to a hot fluid comprising a compound or composition of the present invention at a temperature of from about 250° F. to about 270° F., preferably in a substantially sealed chamber. The process can be completed usually in less than about 2 hours. However, some articles, such as plastic articles and electrical components, cannot withstand such high temperatures and require low-temperature sterilization.

Low-temperature sterilization of the present invention involves the use of a compound or composition of the present invention at a temperature of from about 100 to about 200° F. The compounds of the present invention may be combined with other common chemical sterilants, including, for example, ethylene oxide (EO), formaldehyde, hydrogen peroxide, chlorine dioxide, and ozone to form a sterilant composition of the present invention.

The low-temperature sterilization of the present invention is preferably at least a two-step process performed in a substantially sealed, preferably air tight, chamber. In the first step (the sterilization step), the articles having been cleaned and wrapped in gas permeable bags are placed in the chamber. Air is then evacuated from the chamber by pulling a vacuum and perhaps by displacing the air with steam. In certain embodiments, it is preferable to inject steam into the chamber to

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achieve a relative humidity that ranges preferably from about 30% to about 70%. Such humidities may maximize the sterilizing effectiveness of the sterilant which is introduced into the chamber after the desired relative humidity is achieved. After a period of time sufficient for the sterilant to permeate the wrapping and reach the interstices of the article, the sterilant and steam are evacuated from the chamber.

In the preferred second step of the process (the aeration step), the articles are aerated to remove sterilant residues. Removing such residues is particularly important in the case of toxic sterilants, although it is optional in those cases in which the substantially non-toxic compounds of the present invention are used. Typical aeration processes include air washes, continuous aeration, and a combination of the two. An air wash is a batch process and usually comprises evacuating the chamber for a relatively short period, for example, 12 minutes, and then introducing air at atmospheric pressure or higher into the chamber. This cycle is repeated any number of times until the desired removal of sterilant is achieved. Continuous aeration typically involves introducing air through an inlet at one side of the chamber and then drawing it out through an outlet on the other side of the chamber by applying a slight vacuum to the outlet. Frequently, the two approaches are combined. For example, a common approach involves performing air washes and then an aeration cycle.

EXAMPLES

The following examples are provided for the purpose of illustrating the present invention but without limiting the scope thereof.

Example 1

The coefficient of performance (COP) is a universally accepted measure of refrigerant performance, especially useful in representing the relative thermodynamic efficiency of a refrigerant in a specific heating or cooling cycle involving evaporation or condensation of the refrigerant. In refrigeration engineering, this term expresses the ratio of useful refrigeration to the energy applied by the compressor in compressing the vapor. The capacity of a refrigerant represents the amount of cooling or heating it provides and provides some measure of the capability of a compressor to pump quantities of heat for a given volumetric flow rate of refrigerant. In other words, given a specific compressor, a refrigerant with a higher capacity will deliver more cooling or heating power. One means for estimating COP of a refrigerant at specific operating conditions is from the thermodynamic properties of the refrigerant using standard refrigeration cycle analysis techniques (see for example, R. C. Downing, FLUOROCARBON REFRIGERANTS HANDBOOK, Chapter 3, Prentice-Hall, 1988).

A refrigeration/air conditioning cycle system is provided where the condenser temperature is about 150° F. and the evaporator temperature is about -35° F. under nominally isentropic compression with a compressor inlet temperature of about 50° F. COP is determined for several compositions of the present invention over a range of condenser and evaporator temperatures and reported in Table I below, based upon HFC-134a having a COP value of 1.00, a capacity value of 1.00 and a discharge temperature of 175° F.

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TABLE I

REFRIGERANT COMPOSITION	Relative COP	Relative CAPACITY	DISCHARGE TEMPERATURE (° F.)
HFO 1225ye	1.02	0.76	158
HFO trans-1234ze	1.04	0.70	165
HFO cis-1234ze	1.13	0.36	155
HFO 1234yf	0.98	1.10	168

This example shows that certain of the preferred compounds for use with the present compositions each have a better energy efficiency than HFC-134a (1.02, 1.04 and 1.13 compared to 1.00) and the compressor using the present refrigerant compositions will produce discharge temperatures (158, 165 and 155 compared to 175), which is advantageous since such result will likely leading to reduced maintenance problems.

Example 2

The miscibility of HFO-1225ye and HFO-1234ze with various refrigeration lubricants is tested. The lubricants tested are mineral oil (C3), alkyl benzene (Zerol 150), ester oil (Mobil EAL 22 cc and Solest 120), polyalkylene glycol (PAG) oil (Goodwrench Refrigeration Oil for 134a systems), and a poly(alpha-olefin) oil (CP-6005-100). For each refrigerant/oil combination, three compositions are tested, namely 5, 20 and 50 weight percent of lubricant, with the balance of each being the compound of the present invention being tested.

The lubricant compositions are placed in heavy-walled glass tubes. The tubes are evacuated, the refrigerant compound in accordance with the present invention is added, and the tubes are then sealed. The tubes are then put into an air bath environmental chamber, the temperature of which is varied from about -50° C. to 70° C. At roughly 10° C. intervals, visual observations of the tube contents are made for the existence of one or more liquid phases. In a case where more than one liquid phase is observed, the mixture is reported to be immiscible. In a case where there is only one liquid phase observed, the mixture is reported to be miscible. In those cases where two liquid phases were observed, but with one of the liquid phases occupying only a very small volume, the mixture is reported to be partially miscible.

The polyalkylene glycol and ester oil lubricants were judged to be miscible in all tested proportions over the entire temperature range, except that for the HFO-1225ye mixtures with polyalkylene glycol, the refrigerant mixture was found to be immiscible over the temperature range of -50° C. to -30° C. and to be partially miscible over from -20 to 50° C. At 50 weight percent concentration of the PAG in refrigerant and at 60°, the refrigerant/PAG mixture was miscible. At 70° C., it was miscible from 5 weight percent lubricant in refrigerant to 50 weight percent lubricant in refrigerant.

Example 3

The compatibility of the refrigerant compounds and compositions of the present invention with PAG lubricating oils while in contact with metals used in refrigeration and air conditioning systems is tested at 350° C., representing conditions much more severe than are found in many refrigeration and air conditioning applications.

Aluminum, copper and steel coupons are added to heavy walled glass tubes. Two grams of oil are added to the tubes.

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The tubes are then evacuated and one gram of refrigerant is added. The tubes are put into an oven at 350° F. for one week and visual observations are made. At the end of the exposure period, the tubes are removed.

This procedure was done for the following combinations of oil and the compound of the present invention:

- a) HFC-1234ze and GM Goodwrench PAG oil
- b) HFC-1243 zf and GM Goodwrench oil PAG oil
- c) HFC-1234ze and MOPAR-56 PAG oil
- d) HFC-1243 zf and MOPAR-56 PAG oil
- e) HFC-1225 ye and MOPAR-56 PAG oil.

In all cases, there is minimal change in the appearance of the contents of the tube. This indicates that the refrigerant compounds and compositions of the present invention are stable in contact with aluminum, steel and copper found in refrigeration and air conditioning systems, and the types of lubricating oils that are likely to be included in such compositions or used with such compositions in these types of systems.

Comparative Example

Aluminum, copper and steel coupons are added to a heavy walled glass tube with mineral oil and CFC-12 and heated for one week at 350° C., as in Example 3. At the end of the exposure period, the tube is removed and visual observations are made. The liquid contents are observed to turn black, indicating there is severe decomposition of the contents of the tube.

CFC-12 and mineral oil have heretofore been the combination of choice in many refrigerant systems and methods. Thus, the refrigerant compounds and compositions of the present invention possess significantly better stability with many commonly used lubricating oils than the widely-used prior art refrigerant-lubricating oil combination.

What is claimed is:

1. A heat transfer composition for use in an air conditioning system comprising:

- (a) at least about 50% by weight of 1,1,1,2-tetrafluoropropene (HFO-1234yf) having no substantial acute toxicity; and
- (b) at least one poly alkylene glycol lubricant in the form of a homopolymer or co-polymer consisting of 2 or more oxypropylene groups and having a viscosity of from about 10 to about 200 centistokes at about 37° C.

2. The composition of claim 1 having a Global Warming Potential (GWP) of not greater than about 150.

3. The heat transfer composition of claim 1 further comprising at least one compatibilizer.

4. The heat transfer composition of claim 1 wherein said lubricant is present in an amount of at least about 30% by weight.

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5. The composition of claim 1 wherein said lubricant is present in an amount of about 5% by weight of the composition.

6. The composition of claim 1 wherein said lubricant is present in an amount of about 20% by weight of the composition.

7. The composition of claim 1 wherein said lubricant is present in an amount of about 50% by weight composition.

8. The composition of claim 1 wherein said composition is non-flammable.

9. The composition of claim 1 having a Global Warming Potential (GWP) of not greater than about 100.

10. The composition of claim 1 having a Global Warming Potential (GWP) of not greater than about 75.

11. The composition of claim 1 having an ozone depletion potential (ODP) of not greater than about 0.02.

12. The composition of claim 1 wherein said HFO-1234yf comprises at least about 70% by weight of the composition.

13. The composition of claim 3 wherein said compatibilizer is selected from the group consisting of propane, butane, pentane and combinations of these.

14. The composition of claim 3 comprising compatibilizer in amounts of from about 0.5 to about 5 percent by weight of the composition.

15. The composition of claim 1 having a capacity relative to HFC-134a of about 1.

16. The composition of claim 1 having a coefficient of performance (COP) relative to HFC-134a of about 1.

17. The composition of claim 1 comprising said lubricant in an amount of from about 30 to about 50% by weight.

18. The composition of claim 1 further comprising a surfactant and a solubilizing agent.

19. The composition of claim 1 wherein said lubricant further comprises at least one polyol ester.

20. The composition of claim 1 having a capacity relative to HFC-134a of about 1 and having a coefficient of performance (COP) relative to HFC-134a of about 1.

21. The composition of claim 1 wherein said composition has one liquid phase at at least one temperature between about -50° C. and +70° C.

22. The composition of claim 1 being stable when in contact with aluminum, steel and copper under the conditions of use in refrigeration and air conditioning systems.

23. The composition of claim 1 consisting essentially of said HFO-1234yf and said lubricant.

24. The composition of claim 1 wherein said lubricant has a viscosity of from about 30 to about 150 centistokes at about 37° C.

25. The composition of claim 24 consisting essentially of said HFO-1234yf and said lubricant.

* * * * *

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non-compliance stated in the notification, that appellant's rebuttal brief and any amended rebuttal brief by that appellant will not be considered.

§ 41.73 Oral hearing.

(a) An oral hearing should be requested only in those circumstances in which an appellant or a respondent considers such a hearing necessary or desirable for a proper presentation of the appeal. An appeal decided on the briefs without an oral hearing will receive the same consideration by the Board as an appeal decided after an oral hearing.

(b) If an appellant or a respondent desires an oral hearing, he or she must file, as a separate paper captioned "REQUEST FOR ORAL HEARING," a written request for such hearing accompanied by the fee set forth in § 41.20(b)(3) within two months after the date of the examiner's answer. The time for requesting an oral hearing may not be extended. The request must include a certification that a copy of the request has been served in its entirety on all other parties to the proceeding. The names and addresses of the parties served must be indicated.

(c) If no request and fee for oral hearing have been timely filed by appellant or respondent as required by paragraph (b) of this section, the appeal will be assigned for consideration and decision on the briefs without an oral hearing.

(d) If appellant or respondent has complied with all the requirements of paragraph (b) of this section, a hearing date will be set, and notice given to the owner and all requesters. If an oral hearing is held, an oral argument may be presented by, or on behalf of, the primary examiner if considered desirable by either the primary examiner or the Board. The notice shall set a non-extendable period within which all requests for oral hearing shall be submitted by any other party to the appeal desiring to participate in the oral hearing. A hearing will be held as stated in the notice, and oral argument will be limited to thirty minutes for each appellant or respondent who has requested an oral hearing, and twenty minutes for the primary examiner unless otherwise ordered. No appellant or respondent will be permitted to par-

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ticipate in an oral hearing unless he or she has requested an oral hearing and submitted the fee set forth in § 41.20(b)(3).

(e)(1) At the oral hearing, each appellant and respondent may only rely on evidence that has been previously entered and considered by the primary examiner and present argument that has been relied upon in the briefs except as permitted by paragraph (e)(2) of this section. The primary examiner may only rely on argument and evidence relied upon in an answer except as permitted by paragraph (e)(2) of this section. The Board will determine the order of the arguments presented at the oral hearing.

(2) Upon a showing of good cause, appellant, respondent and/or the primary examiner may rely on a new argument based upon a recent relevant decision of either the Board or a Federal Court.

(f) Notwithstanding the submission of a request for oral hearing complying with this rule, if the Board decides that a hearing is not necessary, the Board will so notify the owner and all requesters.

§ 41.77 Decisions and other actions by the Board.

(a) The Board of Patent Appeals and Interferences, in its decision, may affirm or reverse each decision of the examiner on all issues raised on each appealed claim, or remand the reexamination proceeding to the examiner for further consideration. The reversal of the examiner's determination not to make a rejection proposed by the third party requester constitutes a decision adverse to the patentability of the claims which are subject to that proposed rejection which will be set forth in the decision of the Board of Patent Appeals and Interferences as a new ground of rejection under paragraph (b) of this section. The affirmance of the rejection of a claim on any of the grounds specified constitutes a general affirmance of the decision of the examiner on that claim, except as to any ground specifically reversed.

(b) Should the Board reverse the examiner's determination not to make a rejection proposed by a requester, the Board shall set forth in the opinion in support of its decision a new ground of

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rejection; or should the Board have knowledge of any grounds not raised in the appeal for rejecting any pending claim, it may include in its opinion a statement to that effect with its reasons for so holding, which statement shall constitute a new ground of rejection of the claim. Any decision which includes a new ground of rejection pursuant to this paragraph shall not be considered final for judicial review. When the Board makes a new ground of rejection, the owner, within one month from the date of the decision, must exercise one of the following two options with respect to the new ground of rejection to avoid termination of the appeal proceeding as to the rejected claim:

(1) *Reopen prosecution.* The owner may file a response requesting reopening of prosecution before the examiner. Such a response must be either an amendment of the claims so rejected or new evidence relating to the claims so rejected, or both.

(2) *Request rehearing.* The owner may request that the proceeding be reheard under §41.79 by the Board upon the same record. The request for rehearing must address any new ground of rejection and state with particularity the points believed to have been misapprehended or overlooked in entering the new ground of rejection and also state all other grounds upon which rehearing is sought.

(c) Where the owner has filed a response requesting reopening of prosecution under paragraph (b)(1) of this section, any requester, within one month of the date of service of the owner's response, may once file comments on the response. Such written comments must be limited to the issues raised by the Board's opinion reflecting its decision and the owner's response. Any requester that had not previously filed an appeal or cross appeal and is seeking under this subsection to file comments or a reply to the comments is subject to the appeal and brief fees under §41.20(b)(1) and (2), respectively, which must accompany the comments or reply.

(d) Following any response by the owner under paragraph (b)(1) of this section and any written comments from a requester under paragraph (c) of

this section, the proceeding will be remanded to the examiner. The statement of the Board shall be binding upon the examiner unless an amendment or new evidence not previously of record is made which, in the opinion of the examiner, overcomes the new ground of rejection stated in the decision. The examiner will consider any owner response under paragraph (b)(1) of this section and any written comments by a requester under paragraph (c) of this section and issue a determination that the rejection is maintained or has been overcome.

(e) Within one month of the examiner's determination pursuant to paragraph (d) of this section, the owner or any requester may once submit comments in response to the examiner's determination. Within one month of the date of service of comments in response to the examiner's determination, the owner and any requesters may file a reply to the comments. No requester reply may address the comments of any other requester reply. Any requester that had not previously filed an appeal or cross appeal and is seeking under this subsection to file comments or a reply to the comments is subject to the appeal and brief fees under §41.20(b)(1) and (2), respectively, which must accompany the comments or reply.

(f) After submission of any comments and any reply pursuant to paragraph (e) of this section, or after time has expired, the proceeding will be returned to the Board which shall reconsider the matter and issue a new decision. The new decision is deemed to incorporate the earlier decision, except for those portions specifically withdrawn.

(g) The time period set forth in paragraph (b) of this section is subject to the extension of time provisions of §1.956 of this title when the owner is responding under paragraph (b)(1) of this section. The time period set forth in paragraph (b) of this section may not be extended when the owner is responding under paragraph (b)(2) of this section. The time periods set forth in paragraphs (c) and (e) of this section may not be extended.

CERTIFICATE OF SERVICE

On August 16, 2016, the foregoing brief was submitted to the Court by CM/ECF and thereby served on all parties.

/s/ Gregg F. LoCascio, P.C.

**CERTIFICATE OF COMPLIANCE WITH
TYPE-VOLUME LIMITATION**

This brief complies with the type-volume limitation of Federal Rule of Appellate Procedure 28.1(e). According to the word processing system used to prepare this document, the brief contains **13,796** words.

/s/ Gregg F. LoCascio, P.C.

U.S. Patent No. 7,534,366, claims 36, 37, 46-49, 70, and 75, as added in reexamination (Appx2649-2652):

[Group VI]

36. (New) The composition of claim 32 having a Global Warming Potential (GWP) of not greater than about 150.

37. (New) The composition of claim 32 having a Global Warming Potential (GWP) of not greater than about 75.

46. (New & Amended) The composition of claim 36 wherein said composition is stable when in contact with aluminum, steel and cooper [sic] under the conditions of use in the air conditioning system.

47. (New) The composition of claim 46 having a capacity relative to HFC-134a of about 1.

48. (New) The composition of claim 46 having a Coefficient of Performance (COP) relative to HFC-134a of about 1.

49. (New) The composition of claim 46 having a capacity relative to HFC-134a of about 1 and having a Coefficient of Performance (COP) relative to HFC-134a of about 1.

75. (New) The composition of claim 74 having a Global Warming Potential (GWP) of not greater than about 150.

[Group X]

70. (New & Amended) The composition of claim 1 further comprising one or more of difluoromethane (HFC-32), difluoroethane (HFC-152a), propane, hexane, and octane and wherein said composition is nonflammable.